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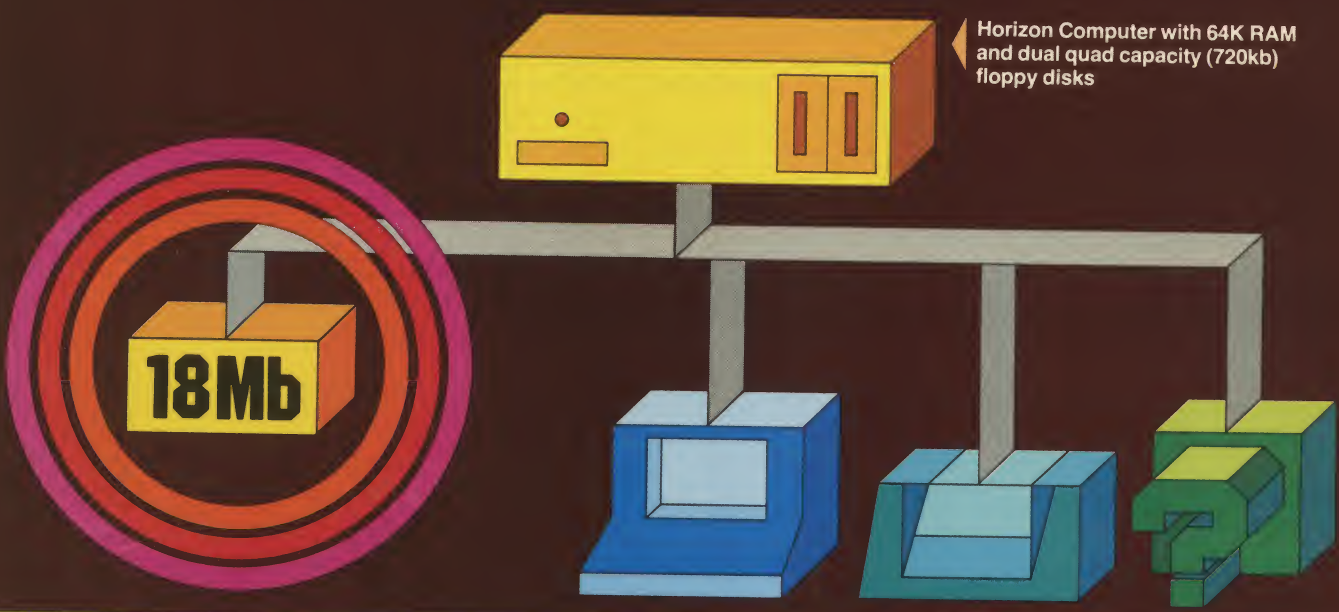

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MICROCOMPUTING™

contents: mar. '80

ARTICLES

DEPARTMENTS

Cover: Photos by Reese Fowler.

micro info

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PUBLISHER'S REMARKS

Wayne Green

Retrospect

As I look at the editorial in the first issue of this magazine, I note that the editorial approach discussed there has remained the same after three years of publication. I promised you lots of relatively simple articles so you would be able to grow to understand all aspects of microcomputers.

Microcomputers constitute an extremely technical subject, and you are to be congratulated for coming so far in such a short time. In truth, though the whole subject is complex, when you break it down into small parts, no little piece is too difficult to understand.

One other concept I covered in that first editorial was publishing software in bulk so it could sell at low prices and still pay the programmer handsomely. When, over a year later, no firm had yet emerged as a result of that editorial, I decided to go ahead and do it myself to get the ball rolling. By January of 1979, Instant Software had its own building and the beginnings of a staff. Today, ISI programs are being sold through several hundred computer stores in the U.S. and in over 20 countries around the world.

As more microcomputers have been sold the magazine has brought you more useful software . . . and you haven't seen anything yet.

The advertising, which helps make the magazine possible and brings you news of the latest products, has grown steadily. In the last year the advertising has increased 64 percent. That means more pages of articles for you every month.

In addition to software and articles that help you understand how microcomputers work, you also see more reviews of new products . . . a service that could save you a lot of money by steering you toward the better hardware and software. There is, unfortunately, a lot of dubious software being marketed.

For instance, one chap contracted to have software written. When the programmer sent him the first draft to check, he went right ahead and marketed it, screwing the programmer out of his money and doing the same to buyers because the software did not yet work. Another outfit marketed some outdated public-domain programs.

Our microcomputer lab is complete, and you can be sure that you are reasonably protected when you buy something that has been checked out by our staff.

I steered you away from some bad ideas: paper bits, floppy ROMs. I looked over the latter idea and decided that it would never really fly; it has never flown.

Stick with us and you'll save time and money.

Why I Like . . . . .

One of the big problems facing newcomers to microcomputers is the choice of system to buy. Most of us have a good answer for that, though I expect that the answer from each hobbyist will be different. I would like to see a series of articles about the available microcomputers, written by hobbyists who have used them and understand them.

The series would be aimed at helping newcomers understand the differences between systems—what the benefits of one particular system are—and why they should buy a particular system. We're looking for comprehensive, well-planned articles that cover both the pros and cons of a system.

Most of the material available on systems is from manufacturers, so there is always that nagging doubt that some slight impartiality will seep through the ads and spec sheets. Newcomers want to get advice from someone who has bought a system, lived with it, expanded it and found some use for it. Let's see some articles.

What systems? Anything and everything that is still available. What say, you Apple fans . . . you Sorcerer boosters?

We want to know what troubles you had starting your system, what help you got from your dealer or from the factory. We want to know what accessories you've used with it. We want to know how you like it. We want to know about additional memory, disk units, printers, software you've tried and liked or hated, utilities that have helped or hindered you. Drag out your notebook and tell all.

Any Educators out There?

Both Nathaniel Hawthorne College of Antrim, New Hampshire, and Franklin Pierce College of Rindge, New Hampshire, are looking for educators with a solid microcomputer background to help them set up and run microcomputer degree courses. They will also need several instructors for technical and lab courses, so this is a fine opportunity to get in on the ground floor.

If you are interested, drop these colleges a line with your resume and a letter explaining what you can do for them.

Merle Jones, dean of administration for Hawthorne College, listed what qualifications the coordinator of the microcomputer program should have: college degree (to fulfill academic credibility); complete background on technical aspects of microcomputer field; good, personable image; ability to speak, project and sell to large or small groups of people the values of microcomputers and their impact on the world in the business field; innovative and tireless approach to work; ability to see, work for, build and realize a dynamic successful microcomputer program for Nathaniel Hawthorne College.

Merle also is looking for teachers and technicians for specific microcomputer courses outlined in the curriculum. They should not be as concerned with academic credentials as with knowledge and training in the microcomputer field. As you can see, this is a great opportunity for computerists to enter the education field and help our country produce microcomputer engineers and microcomputer-oriented businessmen.

The future for anyone teaching microcomputers has to be a good one. Tens of thousands of students will have to be taught about microcomputers, and industry is going to need special courses to adapt to the enormous changes microcomputers will bring.

Microcomputers will be used in virtually every aspect of business and communications. Microprocessors will be in most appliances, in homes, in toys.

Businessmen with solid microcomputer/business backgrounds will have to tackle this change in the world. I think the colleges that start in this field now will have the opportunity to grow along with the field. Wouldn't *you* like to be part of that?

Good Publication

As an entrepreneur, I enjoy reading "Computer Opportunities, The Entrepreneur's Newsletter," published monthly by Datasearch, 4954 William Arnold Road, Memphis TN 38117. At $36 a year (U.S. and Canada), it's worth it.

This computer publication keeps an eye out for what is happening in the microcomputer field. I find George Miller, the editor, generally on target with his evaluation of opening microcomputer opportunities.

A recent issue advises that the time for the underfinanced firm to go into microcomputer hardware manufacturing is over. Today you are up against Radio Shack, IBM, TI, Atari, Apple and other firms that are able to invest millions of dollars. The newsletter also mentions that it is time for smaller software firms to team up with one of the big software publishers.

This made me think about larger hardware firms and their need to team up with larger software publishers. If they wait too long, they may trail in sales because they do not have enough applications software.

One of your responsibilities, as a reader of *Kilobaud MICROCOMPUTING*, is to aid and abet the increasing of circulation and advertising, both of which will bring you the same benefit: a larger and even better magazine. You can help by encouraging your friends to subscribe to *Kilobaud MICROCOMPUTING*. Remember: Subscriptions are guaranteed—money back if not delighted, so no one can lose. You can also help by tearing out one of the cards just inside the back cover and circling replies you'd like to see: catalogs, spec sheets, etc. Advertisers put a lot of trust in reader requests for information.

OUTPUT FROM ISI

Sherry Smythe

Programs for Survival

There are very few business programs on the market, and most of those available are getting terrible reviews from the professionals. This presents an opportunity for programmers. The programmer with an edge these days either has a combination programming and specific business background, which enables him to write programs that will please even the experts in a particular field, or else works with a computer store writing business programs on contract. The resulting programs are solid gold if marketed professionally through a large software publisher.

If you are writing a business program that may be used by many other similar firms, be sure to put in options for other ways of running the business. The more flexible you make your program, the easier it will be for computer stores to sell it to their customers . . . and, in turn, probably sell a complete computer system to support it.

Don't worry as much about memory or disk requirements as the completeness of the program. Dealers will be happy to sell more memory to accommodate your program . . . or even an extra disk system if necessary. Some programmers cut the frills from a program to get it under the wire at 4K or 16K, when everyone would be happier if it were more complete, and hang the memory constraints.

The more complete the documentation, the faster a publisher can evaluate and publish a program. Use a typewriter, or at least a good word-processor printer with both uppercase and lowercase letters, for documentation. Double-space for editing and ease of typesetting.

Instant Software programs are racking up good sales records, so plans are being made for a special certificate for authors of programs that sell 10,000 copies. Royalties should be over $10,000 when sales reach certificate level.

If we receive a substantially better program for a particular business application, it will replace the earlier program. To avoid this, programmers should constantly improve their programs to keep them better than any others submitted.

The lack of good business software probably explains the high ratio of hobby to business sales of computers so far. More business programs should spur business-computer sales to surpass hobby sales.

Keep those programs coming in.

PET-POURRI

Robert W. Baker

BASIC Switch Revisited

Past columns have mentioned two models of Small System Services' BASIC Switch designed for 8K PETs. The Model 14 has sockets for both the old and new ROM sets, with a switch to select the desired active set. The Model 15 has an additional 15th socket for another ROM such as the BASIC Toolkit.

I reviewed the Model 15 and its installation on my 8K PET. The excellent manual provided made installation easy, and the unit performed perfectly. The BASIC Switch warranty, however, does not cover installation or use of the ROMs, so you might prefer to have your dealer install the ROMs and complete installation of the BASIC Switch yourself.

Begin the simple installation by removing the old ROM set from the PET and installing the ROMs in the appropriate sockets in the BASIC Switch. An IC puller and a small piece of conductive foam included with the BASIC Switch make the job easy and safe. You can buy retrofit ROMs already installed in the BASIC Switch, or you can install them yourself. Use extreme care when handling the ROMs; they are MOS devices and can easily be damaged by static electricity.

The selection between old and retrofit ROM sets is controlled by a single toggle switch on the BASIC Switch board. Whenever the toggle switch changes, the PET resets automatically, and one of the two LEDs on the board lights to indicate which ROM set is active. The Model 15 has two additional switches for the extra ROM socket. One switch indicates whether the ROM is a 2716 (2K) or a 2732 (4K) ROM (with a single 5 V supply). The other switch enables or disables the extra ROM. Whenever the extra socket is disabled, all devices connected to the memory expansion port should operate normally; this includes any other ROM occupying the same address space selected for the 15th socket of the BASIC Switch.

Addressing the 15th socket will pull the READ/WRITE signal on the expansion port to the WRITE state (LOW). This disables any ROM that occupies the same address space as the 15th socket. Other devices that occupy the same address space need not be turned off if writing to those addresses will not cause problems. Disable the 15th socket before you insert or remove a ROM. This also disconnects the 5 V supply to the socket and avoids any damage to the ROM.

Following the detailed procedures and diagrams in the manual, install the connecting cable in the PET by first attaching a plastic cable clip with an adhesive back to the PET cabinet to hold the wiring harness in place. Insert a DIP header attached to the main ribbon cable into the correct socket where one of the original ROMs was removed from the PET. Then insert five color-coded wires with pin plugs into various pins of three of the remaining ROM sockets, and attach a micro-clip to a resistor on the main PET board. The Model 15 has three additional micro-clips attached to various com-

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ponents on the main PC board. One of these clips selects the 4K address block of the 15th ROM as described in the manual.

The Model 15 comes with a plastic protective case that is optional with the Model 14. Since it is normal for both ROM sets to warm up when power is on, you should keep the case open when using the PET. Keep the case open anyway, since the selection switches are mounted on the PC board and are not accessible through the case.

The manual suggests running the ROM tests after completing the installation to verify correct installation. Warm up the ROMs for about ten minutes before running the tests. If you have any problems or questions, call the company collect for help.

Both models of the BASIC Switch are available for either type of ROM used on 8K PETs. When ordering a unit you should indicate what type ROMs you have and/or your PET serial number to get the correct unit for your system.

Presto Digitizer Tablet

Ready for something really new for your PET? Then take a look at the new peripheral device from Innovision that lets you enter data into the PET as easily as if you were using a pencil and paper. The Presto Digitizer Tablet consists of a special writing surface mounted in a plastic frame. A wire extending from the frame is connected to a pen-like stylus that you hold like a writing instrument. A separate multiconductor cable terminates at a connector that plugs into the PET user port, providing the interface to the PET.

The writing surface of the tablet is an etched printed circuit board divided into seven distinct regions (see Fig. 1). Each region except region 4 connects to a user port input bit. Regions 1 through 6 are used for writing the character to be recognized, then region 7 is touched to indicate that a character is completed. When you enter a character on the tablet, simply slide the metal tip of the stylus on the Presto Digitizer writing surface. The stylus does scratch the tablet's copper surface, but is should still last for quite a while, with care. The surface must be kept clean.

All letters of the alphabet, as well as numerals and several punctuation and mathematical symbols, are distinguished from each other by stroke direction. For example, the letter B can be drawn using two strokes (see Fig. 2). The PET can be programmed to recognize the sequence in which the regions are touched as being uniquely associated with B.

In this example, the sequence is 13512365.

Because the PET is only watching for transitions between various regions, you can change the size of your letters somewhat and write quickly or slowly without confusing the PET. However, you do have to be careful in composing certain characters—G, K, M, Q, T, V, W, X, Y—since there are several ways to make them. To overcome this, the PET can be programmed to recognize more than one sequence code for each character.

The Presto Digitizer Tablet can be used for graphics input with a set of stroke sequences defined for horizontal and vertical lines and four rounded corners. This provides possibilities for sketching-type programs with PET graphics.

The tablet comes completely assembled with an instruction manual and two sample programs on cassette. The manual mentions the possibility of future application programs written for the tablet and welcomes requests for special program needs. It describes how to use and care for the tablet as well as how to run the sample programs and write your own. The sample programs familiarize the user with the tablet as an input device. The second program can also be used to teach the tablet to recognize particular users' printing style.

At a list price of $48.50, the Presto Digitizer Tablet is well constructed and nicely packaged; it should interest any PET user. If not available locally, it can be ordered directly from Innovision, PO Box 1317, Los Altos CA 94022. Include $1.50 extra for shipping and handling. California residents, add 6.5 percent tax.

New Programs from NEECO

The new catalog from New England Electronics, Needham MA, lists many new programs for the PET. One is a tutorial system that allows any teacher to create computer-aided instruction tapes without any programming knowledge. The program package runs on an 8K PET and can provide sound effects. Lessons can be edited or copied. The complete package is only $29.95.

I was happy to see two of my programs listed in the catalog. The first is a machine-language utility for the 8K PET that displays a symbol table cross-reference showing all variables used in a BASIC program. Entering any symbol will display the line numbers of all BASIC statements that contain the selected variable. Variables can be selected one after another, and you can redisplay the complete symbol table at any time. This program is helpful for debugging or enhancing a BASIC program written by someone else.

Second is a Household Inventory program that records important information for all your personal possessions. It can create, edit or display tape data files, but some functions require two tape drives. The program will work with only a single drive, but you cannot edit or copy the files. Each program is $14.95.

Many other programs are listed in the new catalog, so be sure you get a copy. NEECO is one of the largest dealers for PET equipment and software and gives excellent service.

New Products for the New PETs

Small System Services has announced three new products for the 16K and 32K PETs. The Space Maker allows you to connect two ROMs to the same expansion socket of the PET and select which one to use. This provides the capability to install the Commodore Word Processor and the PET Toolkit ROMs at the same time, even though they occupy the same address space. The Space Maker can be used in any of the three ROM expansion

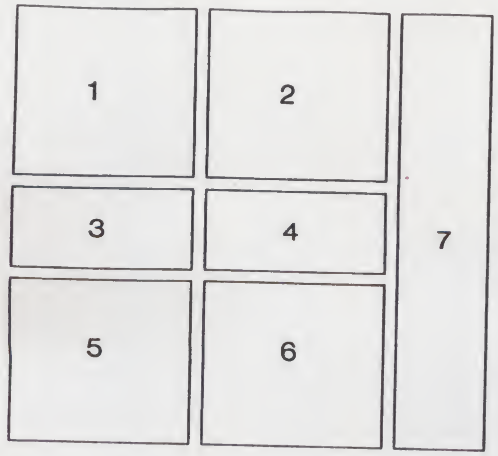


Fig. 1. Top view of tablet with regions labeled.

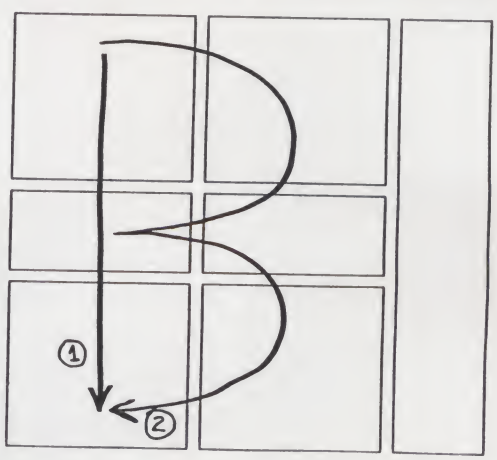


Fig. 2. Two strokes used to draw the letter B.

sockets of the new PETs.

The ROM Driver is a separate controller board that mounts inside the PET and provides software selection of ROMs mounted in Space Makers. A single ROM Driver can control up to three Space Makers, or multiple ROM Drivers can be daisy-chained to select 1-of-4 ROMs in a single ROM expansion socket. ROM Drivers can also be used to select pairs or sets of ROMs.

The User I/O Pack provides the same functional features as the ROM Driver but uses the PET user port instead of a separate controller board. It consists of a user port connector with several jumper wires and a software pack on diskette.

The Space Maker lists for $27, the ROM Driver is $37 and the User I/O Pack is $12.95. A Computhink option should soon be available for PET owners with Computhink disk drives. For more information on any of these products, contact Small System Services, 900 Spring Garden St., Greensboro NC 27403.

Date Book Program

This simple program (see listing) records family birthdays and anniversaries or keeps an appointment calendar. Important dates can be listed by individual months, or the entire list can be displayed. The program can be easily modified to print a list of dates.

Important dates are recorded in data statements after line 530. The first two characters of each entry must be decimal numbers indicating the month of the entry. For simplicity, I enter data with a line number constructed from the date in the entry, with one entry per DATA statement. The month provides the thousands digits (1000–12000) while the actual day of the month provides the hundreds and tens digits (10–310).

If multiple entries occur for the same date, the ones digit identifies each as shown at lines 2240 and 2241. This scheme makes it easy to locate data in the program source for corrections and additions. The dates are not sorted or rearranged by the program, so they should be entered in the order they are to be listed. It's also a good idea to include a REMark statement near the beginning of the program to record the date when you make changes or additions to the data (line 4).

This program isn't fancy, but it works and it's simple to use. I haven't missed a family birthday or anniversary since I started using it.

Next time, I'll POKE around in BASIC. Please address all correspondence directly to Bob Baker, 15 Windsor Drive, Atco NJ 08004.

```
1 REM --------------------------------
2 REM DATE BOOK - BY ROBERT W. BAKER
3 REM --------------------------------
4 REM LAST UPDATE: MM/DD/YY
5 REM --------------------------------
6:
10 PRINT"█   **** █DATE BOOK█ ****██
20 PRINT"DISPLAY MONTH (1-12, █A█LL)";
30 INPUT M$
40 M=VAL(M$)
50 IF M$="A" THEN 70
60 IF M<1 OR M>12 THEN END
70 RESTORE
80 PRINT"█";
90 L=0
100 READ R$
110 IF R$="END" THEN GOSUB 500:GOTO 10
120 IF M=0 OR VAL(LEFT$(R$,2))=M THEN
    PRINT R$ : L=L+1
130 IF L<21 THEN 100
140 GOSUB 500 : GOTO 80
500 PRINT"█────────────────────────────
510 PRINT"DEPRESS ANY KEY TO CONTINUE
520 GET C$ : IF C$="" THEN 520
530 RETURN
1020 DATA"01/02  JOHN E. DOE (1975)
2240 DATA"02/24  PAUL/SUE ANNIV-1942
2241 DATA"02/24  HAIRY APE (1899)
63000 DATA"END
```

Date Book program.

In the December 1979 issue, Len Lindsay reviewed one of our products, a PET Quick Reference Card. Unfortunately, the price of the card was erroneously quoted as $2. The cards are $3.50 (including postage and handling). As a result, we have a problem on our hands.

Because of our faith in both our product and our customers, we have decided as a temporary solution, to fill as many of these orders as we can. We will inform our customers of the error made, and request them to remit the balance to us. In this manner, the many people that have already ordered and received our product at $3.50 will not feel "ripped off," and we will receive a minimum of $2 orders.

Henry R. Martinez
Leading Edge Co.
4471 Santa Monica Blvd.
Los Angeles CA 90029

COMPUTER CLINIC

I would like to hear from anyone who has used MZOS on a Vector Graphic MZ system to load North Star software. We have access to a North Star Horizon II, but the MZOS manual gives no specifics on how the actual process goes. Has anyone successfully done this?

Charles W. Lawson
1740 13th St.
Gering NE 69341

For my organization's use, I am seeking the names and addresses of companies that might specialize in data conversion. More specifically, I am looking for conversion capability from the mini to the maxi floppy disk; however, any company that specializes in data conversion is of interest to me.

Merisue Hazzard
Florida Area I Foundation
for Professional Standards
Review, Inc.
PO Box 1758
Panama City FL 32401

Can anyone provide us with information on the uses of microcomputers in the classroom, also on methods of funding their purchase through Federal Title 1 or other federal monies? We are especially interested in the following areas: Title 1 reading programs and possible applications to teaching junior-high students the wide variety of reading skills, application to programs for the gifted student, administrative uses of the microcomputer (scheduling, record keeping, etc.), in-service training for teachers using the computers and methods for writing Title 1 grant applications to purchase hardware and/or software.

Robert Israel, Principal
Reed Junior High School
Springfield MO 65802

Got a problem?
Let your fellow readers
help you in Computer Clinic.

CONTEST

Winner of the "best article of the month" for December is Leonard Kilian, author of "The BASICs of Computer Art."

Keep an eye out for the winner of "best article of the year."

PHOTOS

We're looking for creative color photographs showing computers in practical applications, especially good photos to accompany articles. If you have something you think we can use, we're interested in looking at it. Any that are used will be paid for on publication. Unused submissions cannot be returned without an SASE. Address submissions to Editorial Dept., Kilobaud Microcomputing, Peterborough NH 03458.

OHIO SCIENTIFIC'S ✓O13

SMALL SYSTEMS JOURNAL

Introduction

OHIO SCIENTIFIC MULTIPLE USER SYSTEMS

This article is the first of a two-part series (continuing next month) on multiple user systems.

A multiple user system is simply a computer (or group of computers) capable of supporting more than one operator at a time. Ohio Scientific offers two approaches to this function. The first approach is a timeshared system, and the second is a networked system.

Timesharing

A timeshared computer system allows a single CPU (Central Processor Unit) to be accessed by several independent user programs. The general configuration of this type of system is one computer mainframe with multiple terminals. Each user terminal may be operated independently of the others.

Networking

A networked computer system allows several independent computers to be tied together. This allows a common or shared data base to be accessed by all computers in the network. Additionally, it is possible to configure computers in the network as timeshared systems.

An example of a timeshared system could be multiple sales terminals tied into one timeshared 'sales' computer. Each salesperson could independently access a sales data base. The 'sales' computer of this example could (initially or eventually) be networked with inventory and/or shipping/receiving computers. This would give each salesperson independent access not only to a sales data base, but also inventory, shipping and receiving data bases.

Ohio Scientific offers timesharing on all systems capable of supporting Level 3 software. Networking is available on the above computers, providing that a C3-C or C3-B hard disk system occupies a Network Node (master position).

This first part of this series will be confined to the hardware and software used for timesharing systems. The second portion (next month) will discuss the Ohio Scientific Network System.

Ohio Scientific Timesharing System—Hardware

To be able to run timesharing on an Ohio Scientific Challenger 3 computer, the following minimum hardware is required:

16-slot mainframe computer
Floppy disk drives / hard disk drive
Multiple partitioned memory
Multiple user terminal interface

Due to the fact that additional slots of the motherboard will be required for memory and peripheral cards, it is recommended that a 16-slot backplane be used. Although 65U Level 3 timeshare can be run using floppies, it is recommended that a hard disk based system be used. This will increase the throughput for each individual user as disk accesses are many times faster than floppy transfers. Another advantage of a hard disk based system is that all transfers are done through a dual port memory and intelligent controller which does not tie up computer time during the transfer. This is not the case with floppy transfers which can take hundreds of milliseconds of computer time with interrupts locked out as transfers are done on the fly with the CPU handling each byte. As individual users are serviced via interrupts this can affect response time to individual users.

Memory Requirements

In a Level 3 system each user has his own terminal and his own memory partition. The base partition is required to have 48 kilobytes of memory. This allows for one user. Each additional user is required to have a minimum of 32 kilobytes to a maximum of 48 kilobytes of memory. Since each user has his own separate memory, a common shared memory is required for the executive program. This resides at $D000_{16}$ and is 4 kilobytes long. Assuming four users with user 0 being the base partition and each additional user having 48 kilobytes of memory then a total of 200 kilobytes of memory would be installed in the machine.

The memory requirements can be met in several ways depending on the number of users required. Ohio Scientific currently has three memory boards available for Level 3 partition use.

The first of these is the CM-3, 16K static RAM board. It has the advantage of being low power and running at .7 MIPS (million instructions per second). Being low power allows up to ten CM-3 memory boards to run in a standard C3 16-slot computer. A maximum of four partitions may be used due to addressing limitations on the memory board.

The CM-9 is a 24 kilobyte static memory board capable of running at .7 MIPS. Its primary advantages are that its addressing allows up to 16 partitions to be selected and it offers more memory per motherboard slot than the CM-3. It does consume about 2.9A of +5 volt power which requires the use of a switching power supply for multiple users.

The CM-6, which is a 48K dynamic memory board, offers the highest memory density per slot. It also has the advantage of being able to be addressed for sixteen different partitions. In addition, it is a low power board allowing the user to fully populate a 16-slot Challenger 3 with CM-6's using the standard power supplies. Also, this board gives the lowest cost per bit for memory. However, it is limited to running at .35 MIPS.

Depending upon the cost performance requirements of the user, a system can be configured at less cost with some reduction in performance or higher performance with some additional cost.

In addition to user memories, the following additional hardware must be included: four kilobytes of executive memory, serial ports for user terminals, printer interfaces and the real time clock.

555 Board

Several of these requirements are met with a new Ohio Scientific 555 board. This board may be populated in a variety of ways with the maximum configuration being 8K of RAM, baud rate generator, five serial ports, parallel word processing printer port, and parallel Centronics printer port. The 555 board can be partially populated if desired. In particular, it may be strapped for a 4 kilobyte block at $D000_{16}$ for the executive program. In addition, if a maximum of four timesharing users are expected, its serial ports may be used for them. Also, the parallel printer ports may be populated at the factory as extra cost options. The primary advantage of this board is that formerly these functions required four motherboard slots instead of the one slot required with the 555 board. Additional ways of configuring and addressing the 555 board will be covered in the next article under networking.

Serial Interfacing

If the end user will require more than four timesharing users, then a CA-10-X board may be installed for a maximum of 16 serial ports for Level 3 operation. Note in this case the ports on the 555 board would be readdressed or not populated depending upon the intial system configuration.

As each active user requires his own terminal, one serial port is required for each user. In addition to the user ports, an additional port is required which is designated the console port. The console port is located on the CPU board. This port is the one used normally during OS-65U operation. During Level 3 operation the console port is not used, instead the serial port used is the user 0 port on the 555 or CA-10-X board. Since the console port and the user 0 port are never used simultaneously, the outputs are or-ed together so that the terminal prints the outputs of both ports. Also, the output of the terminal is fed to both ports. The reason for this particular configuration is that all user ports are interrupt driven whereas the console port is not. This is done to maintain compatibility with earlier Ohio Scientific operating systems.

Real Time Clock

In addition to user inputs and outputs generating interrupts, two additional interrupts are generated by the system hardware. These are real time clock interrupts which generate interrupts every 20 milliseconds and one second. The 20 millisecond interrupt is used to time slice CPU time between the various users. The one second interrupt is used for the software time of day clock. The circuitry for the real time clock is located on the floppy interface board.

Partition Addressing

Since the 6502 microprocessor chip has only 16 address lines available, additional lines are required for memory partitioning. This is done by using four output lines of a peripheral interface adapter to address one of sixteen memory partitions. These lines are buffered and drive address lines A16 through A19 on the motherboard bus.

The preceding discussion of hardware requirements for a basic Level 3 system covers primarily hardware. It should be remembered that additional peripherals may be added to the system described. These include but are not limited to printers, modems and tape backup for the Winchester drive.

Ohio Scientific Timesharing System—Software

Ohio Scientific's widely used single user operating system, OS-65U, is also available in a fully compatible timesharing configuration. In addition to the many features this operating system has traditionally provided for the stand-alone user are these additional features provided under timesharing:

—Round-robin CPU sharing of up to 16 users with very low operating system overhead.
—Interrupt driven scheduler clock, real time clock and calendar.
—Interrupt driven terminal input for quick response to user input.
—Countdown timer per user with user task initiation upon timer expiration.
—Automatic coordination of peripheral access including automatic top-of-form on printer between users' reports.
—Complete freedom for each user to customize the operating system to suit his specific application via FLAGs and POKEs.
—Automatic coordination of floppy and hard disk access including a file layout which minimizes contention.
—BASIC language commands for explicit coordination of shared resource access where automatic controls are not provided.

The Level 3 Executive

The OS-65U Level 3 Executive program is the controller of all timesharing operations. It is invoked by merely running the program LEVEL3 after performing a normal boot of OS-65U. The LEVEL3 program loads the timesharing executive into memory at hex D000 (user memory is 0-BFFF), enables interrupts and goes "on-line". The console operator then has the choice of booting all other timesharing users or selectively booting specific users.

Each user's terminal comes up exactly the same way as in a single user system and is operated in exactly the same way. With the exception of some speed reduction when many users are computing simultaneously and during occasional accesses to shared peripherals and files, the operation of the system is the same as the single user version of OS-65U. Consequently, little or no retraining of users or modification of programs is required for timesharing operation.

CPU Sharing

As mentioned earlier, each user in the timesharing system has between 32K and 48K or dedicated memory for his copy of the system and his application programs. This memory is unique to each user—it is not shared. The central processor is a shared resource. Each active user is given access to the CPU for a few milliseconds then the next active user is given the CPU, etc., in a "round robin" fashion. A user also gains control of the processor whenever a key is typed on his terminal. This gives the BASIC interpreter some time to save the input character and echo it back to the user's terminal. Since the switching from one user to the next occurs very rapidly with respect to human perception times, each user appears to have his own processor. If a user's system requests console input and no key has been typed, that user is suspended until a character is received from his terminal. Also, while a user is waiting for a shared peripheral or file he is essentially suspended and receives no processor time. Thus, each user in the timesharing system has the use of the processor 1/n'th of the time, where n is the number of users currently executing—not including those waiting for input or a shared resource.

Reader Service—see page 227

Interrupt Driven Clocks

Two interrupt driven clocks are used in the timesharing system. The scheduler clock interrupts at a rapid rate—every few milliseconds—and is used to switch from each user to the next. The time of day clock interrupts at a one second frequency and is used solely to maintain the time of day and calendar. This design permits high speed synchronous data transfers to be programmed with interrupts locked out for a much longer period of time than would be permitted in a single clock system. Thus, even Ohio Scientific's programmed (non-DMA) transfer floppy disk interface can be used under timesharing. However, direct memory access (DMA) type interfaces—such as Ohio Scientific's hard disk interface—are more suitable to timeshared use.

Interrupt Driven Terminal Input

Each timesharing user's terminal produces a uniquely identifiable interrupt whenever a key is pressed on the terminal keyboard. This signals the timesharing executive which momentarily gives control of the processor to the user's system. The user's system saves the input character in an input buffer and echoes it back to the terminal for display. In this way, the user is given immediate feedback as to the state of the system, unlike some timesharing systems which only provide such feedback at the end of each line of input.

Countdown Timer

A countdown timer capable of timing up to 100 hours is available to each user for watchdog type functions or any other such task to be performed periodically or after an elapsed time. Upon expiration, the timer initiates execution of a specific user application program. The timer can be set to any value and started and stopped by the user either directly or in BASIC program statements.

Shared Device Access Coordination

Peripheral devices, such as the line printer, are shared resources the use of which must be coordinated among timesharing users. Without user coordination, for example, line printer output could be a jumbled mixture of a few characters from one user then a few from another, and so on.

The OS-65U timesharing system insures coordinated peripheral device access by reserving a peripheral device for the first user to actually access it. It remains reserved for that user until his running program terminates or he explicitly releases it by executing a PRINT#n! statement, where n is the peripheral's device number. Another user who attempts to access a previously reserved device has his execution suspended until the device is released at which time he continues execution with the peripheral device reserved on his behalf.

To facilitate shared line printer use. The printer paper is advanced to the top-of-form position whenever the printer is released. Thus, each different user's printed output begins on a new page.

The method used in OS-65U Level 3 for coordination of shared device access eliminates the need for any changes to most application programs. Only programs which never terminate (e.g., always return to a menu program) need any modification and then only the PRINT#n! need be added.

User Customization

As has been mentioned earlier, each timesharing user has a copy of the BASIC interpreter and operating system within his own memory partition. Besides providing for very rapid context switching between users and a high degree of isolation between users, this feature permits each timesharing user to customize his copy of the interpreter and operating system to his specific application needs by using the OS-65U FLAG command and the BASIC POKE command.

Since most application software in use on OS-65U systems today was developed in single user configurations these programs often include and rely upon the ability to invoke many minor changes in system operation through the use of FLAGs and POKEs. Examples of such changes include altering system error actions, permitting input of commas and preventing the use of a control-C to escape from the program mode to the direct mode of BASIC. There are literally hundreds of different POKEs in use today for such purposes. If all users shared a copy of the operating system either a significant additional context switching overhead would exist or such user customizing of the system would have to be disallowed necessitating considerable modification to much existing application software.

However, with the approach used in the OS-65U Level 3 timesharing system each user is free to customize his copy of the interpreter and operating system and no changes are required to existing application programs that utilize these features of the single user version of OS-65U.

Disk Access Coordination

The Level 3 timesharing system provides automatic coordination of disk drive access. Whenever any timesharing user initiates a disk transfer, the accessed disk drive is reserved exclusively for his use until the completion of the transfer. Any other user who attempts to access the drive during the transfer has his execution suspended until the drive again becomes available. At the completion of the transfer in progress he continues executing with the drive reserved for him. The duration of a floppy disk transfer is a few tenths of a second. A hard disk transfer takes only a few milliseconds. Consequently, users' programs access the hard disk with little, if any, noticeable delay. Floppy disk transfers are much slower, however, and some users may notice a delay in the echoing of a character if they're typing at the time or they may notice momentary slower overall program response.

One area for potential conflicts exists in a timeshare system even if files are not shared between users. This occurs when one file ends and another begins within a given disk sector. As an example, user 1 reads the first file and modifies it then user 2 reads the second file, modifies it and writes it back to disk after which user 1 writes his modified file back to disk. Since disk data is blocked by sector, user 2's changes would be lost when user 1 wrote back his modified file plus the unmodified copy of the second file within the same sector. This type of access conflict is completely eliminated in OS-65U Level 3 because all files begin on sector boundaries.

Another area for potential conflicts exists when data files are shared by multiple users; that is, a given data file exists that can be written within the same sector or record by more than one user at the same time. This type of conflict is not fully resolved by any automatic mechanism. For this reason, new BASIC language commands are provided in OS-65U Level 3 so that users can easily implement whatever level of coordination is appropriate.

BASIC Commands for Shared Resource Access Coordination

The two new BASIC commands provided for coordinating the sharing of resources are:

WAIT FOR n and

WAIT CLEAR n, where n = 1 to 200

The WAIT FOR n command reserves resource n if it is not currently reserved by another user. If it is reserved by another user at the

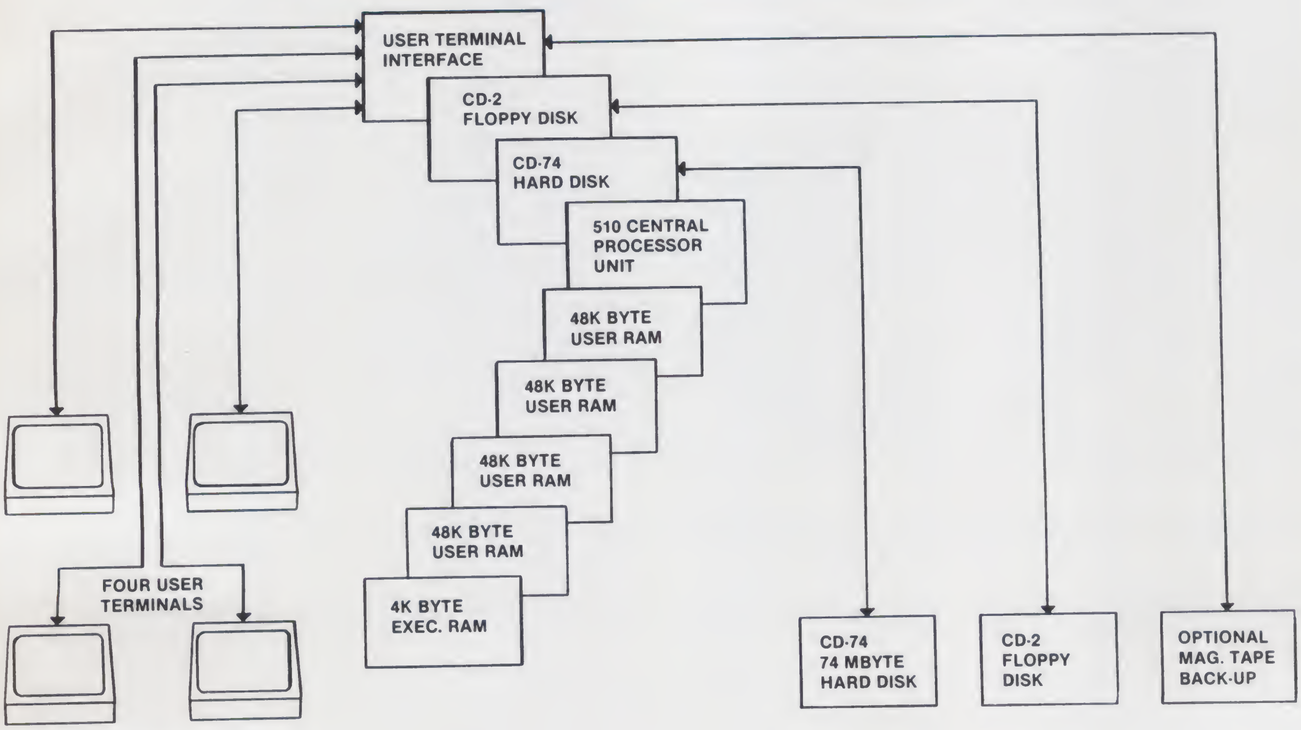
time then the requesting user is suspended until the resource becomes available.

The WAIT CLEAR n command releases a resource which was previously reserved by a WAIT FOR command.

The number, n, used in these commands is strictly arbitrary and has no inherent connection to any particular resource. The various users agree in common on the assignment of numbers to specific resources and to use the commands to coordinate their access to the shared resources.

In some applications it is not desirable to wait for a locked resource. To support this need OS-65U permits the WAIT FOR statement to be time limited up to sixty seconds. After executing the WAIT FOR command the user can then check to determine if he has reserved the needed resource or must try again later.

Detailed documentation supplied in the OS-65U Level 3 programming shows specifically how these commands may be used for various application needs.



Ohio Scientific Timeshare System—Typical Setup and Costs

A typical Ohio Scientific timesharing system could be configured as shown in the preceding diagram.

C3-B	Triple Processor .7 MIPS CPU, Dual Floppies, 52K Static RAM and 74 Megabyte Hard Disk
CM-6	48K Dynamic RAM (3 illustrated)
AC-7B	CRT Terminals (4 illustrated)
-	Terminal Interface and Executive RAM (CM-2 and CA-10-4 or 555 Interface)

The cost of the illustrated system would be as follows:

(1) C3-B	$12,900	
(3) CM-6	1,494	
(4) AC-7B	3,980	
(1) CM-2	99	
(1) CA-10-4	275	
	$18,748	Total

Recommended accessories include:

AC-5	OKIDATA SLIMLINE 120 LPM Printer (not illustrated) at $2,900 including Interface
-	3M Cartridge Tape Backup System available from ALLOY ENGINEERING for approximately $3,500 (CA-10-5 required)

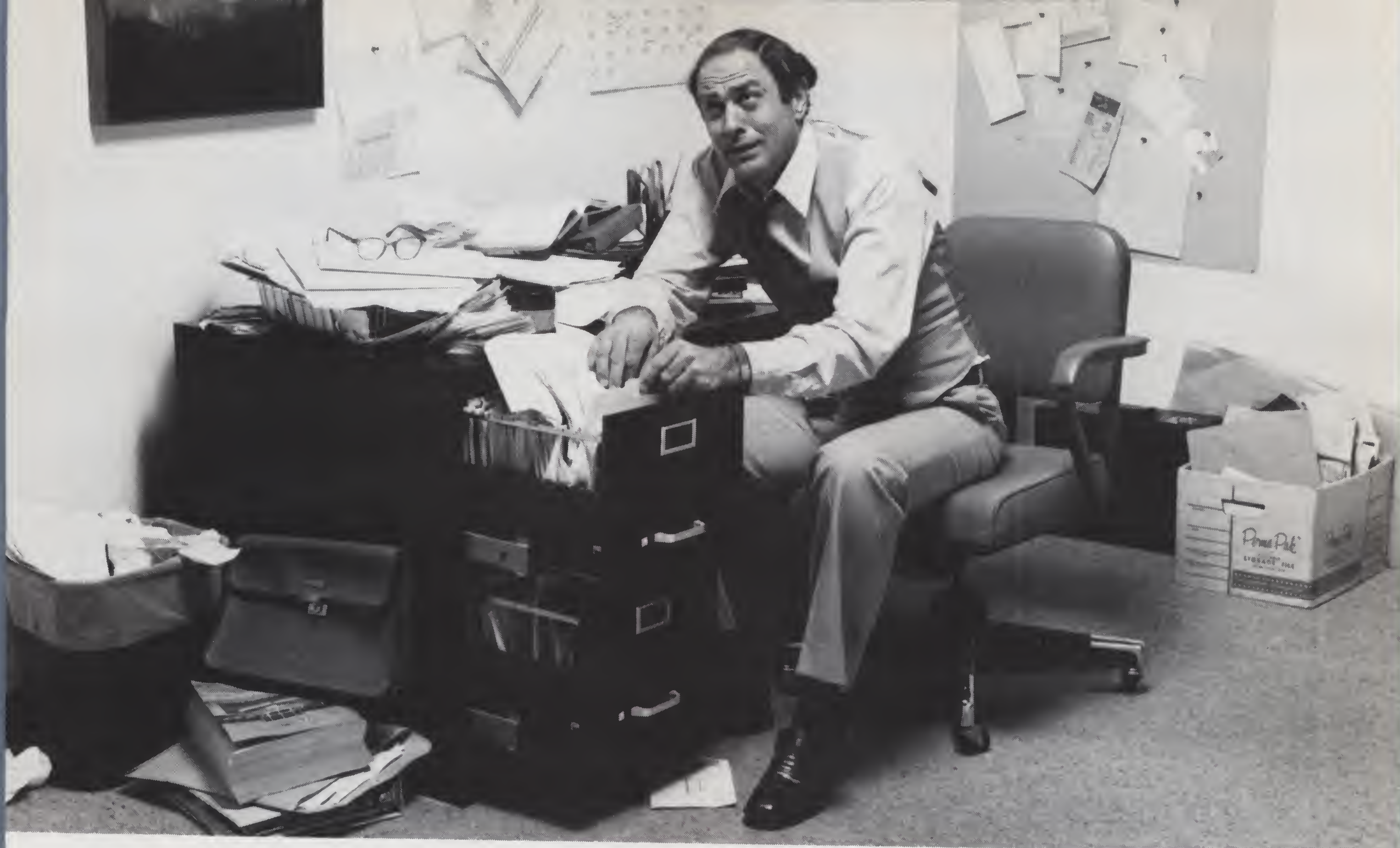
Available software includes:

- OS-65U Level 3 Timeshare Operating System
- OS-DMS
- DMS A/R, A/P
- DMS G/L
- DMS Personnel/Payroll
- DMS Order Entry/(Stock) Inventory
- DMS (Manufacturing) Inventory
- DMS Purchasing
- DMS Query

The OS-65U Level 3 Timeshare Operating System retails for $400—all other listed modules are $300.

This article will conclude (next month) with a discussion of the hardware and software requirements for the Ohio Scientific Networking System.

Reader Service—see page 227



Record keeping problems? Our CCA Data Management System solves them easily.

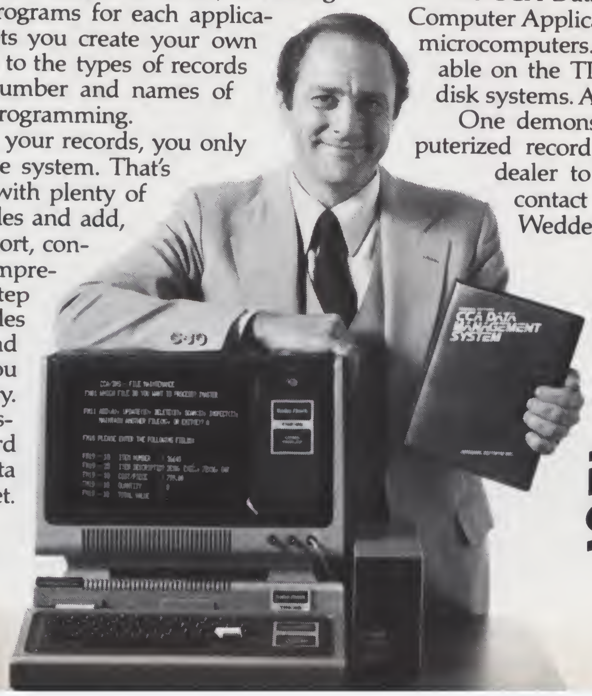
Having information at your fingertips can make your job a whole lot easier. And that's what the CCA Data Management System is all about.

With this Personal Software™ package and an Apple II™ or TRS-80™ disk system, it will be far easier to keep inventories, customer lists, accounts receivable and payable records, patient histories and many more items.

In fact, you can use the CCA DMS for all of your data management needs, rather than buying (expensive) or writing (time consuming) separate programs for each application. That's because DMS lets you create your own filing systems, adapting itself to the types of records you keep. You specify the number and names of each data field—without any programming.

With DMS keeping all of your records, you only have to learn how to use one system. That's easier, too. It's menu driven, with plenty of prompts to help you create files and add, update, scan, inspect, delete, sort, condense and print data. Our comprehensive 130-page step-by-step instruction manual even provides complete "how to" inventory and mailing list applications so you can start processing immediately.

DMS is a very powerful system, with more file and record storage capacity than other data base programs on the market.



And it also gives you greater data handling flexibility. To customize DMS, write add-on BASIC programs that read or write DMS files and perform any kind of processing you want.

You can sort and print your data in nearly any form of report and mailing label you want. Sort data by up to 10 fields for zip code, balance due, geographic location or whatever. And print reports with subtotals and totals automatically calculated.

The CCA Data Management System, written by Creative Computer Applications, has two years of field testing on other microcomputers. Now Personal Software makes DMS available on the TRS-80 Level II and Apple II and II Plus 48k disk systems. And at under $100, DMS is also easy to afford.

One demonstration will convince you how easy computerized record keeping is. Ask your Personal Software dealer to show you. To locate your nearest dealer, contact Personal Software, Inc., (408) 745-7841, 592 Weddell Dr., Sunnyvale, CA 94086.

PERSONAL SOFTWARE

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*Apple is a trademark of Apple Computer, Inc.; TRS-80 is a trademark of the Radio Shack Div. of Tandy Corp.

NEW PRODUCTS

Edited by Dennis Brisson

Computer from Hewlett-Packard

The self-contained HP-85.

The HP-85 computer system from Hewlett-Packard, 1507 Page Mill Rd., Palo Alto CA 94304, features a central processor, typewriter-like keyboard, CRT display, printer, tape cartridge and graphics capability in a fully integrated system the size of a portable electric typewriter. English-like BASIC language programming makes the new system easy to use for those without previous computer experience. A 20-key numeric pad makes data entry or performance of routine arithmetic operations simple.

Although it is designed for personal use in business and industry by professionals, it also can be used in the home by serious hobbyists and as an instructional computer in secondary schools, colleges and universities. All computer parts are in one self-contained unit.

In addition to its built-in interactive graphics, the HP-85 is equipped with four I/O ports to hold a wide range of optional interface modules, such as plotters, printers, disk drives and other peripherals as they become available. It comes with 16K of read/write memory with 14,500 bytes available to the user. The read/write memory can be expanded to 32K (30,500 bytes available) simply by plugging an optional memory module into one of the I/O ports on the back of the machine.

The HP-85's BASIC interpretive language makes available 12-digit accuracy, string operations, editing, 42 predefined functions, four levels of program security and output formatting, which allows headings, columns and spaces. The user can plot data on the graphics display to clarify complex information in easy-to-understand pictorial form. Any display on the CRT can be preserved by printing it with the built-in printer—an operation that can be commanded simply by pressing one key.

The five-inch, high-contrast, high-resolution, black-and-white CRT can display up to 16 lines of data at a time, and each line can contain up to 32 characters. The HP-85 "remembers" up to 64 lines of data, any of which can be viewed by "rolling" the display on the CRT up or down.

The thermal printer, which operates in both alphanumeric and graphics modes, prints two, 32-character lines per second. In the alphanumeric mode it can print the full 128 ASCII character set, which consists of uppercase and lowercase letters, numerals and special symbols. Additionally, the full character set can be underlined, giving the HP-85 printer a 256-character-set capability. In the graphics mode the printer can reproduce any plot on the CRT under program control or user control. When plotting, the printer "rotates" the display 90 degrees, giving it capability to print endless strip charts.

This portable computer (16 × 18 × 6 inches) weighs under 20 lbs. and comes with a 350-page user's manual. Also included is a standard application software package that contains 15 useful programs. Price of the HP-85 is $3250—the optional 16K byte memory expansion module is $395, the application software packages are $95 each, and an optional HP-85 carrying case is $120. Reader Service number H52.

Chieftain Applications Software

Smoke Signal Broadcasting, 31336 Via Colinas, Westlake Village CA 91361, announces three software packages designed to extend the range of applications for the Chieftain small business computer system. Payroll Processing, Inventory Control/Order Entry and Accounts Receivable/Invoice Entry systems run under SSB's random DOS on a 48K byte, 6800 microprocessor with a minimum of 360K of disk storage.

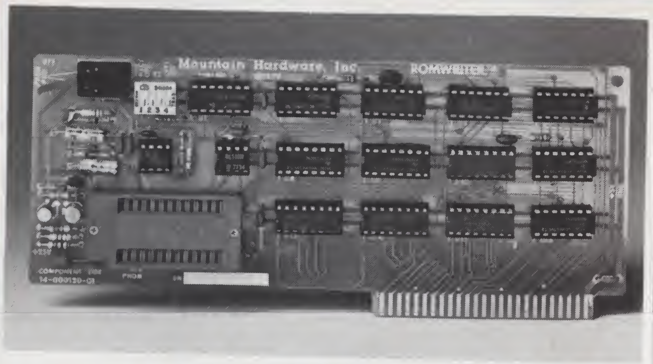
Common program features include direct on-line updating and inquiry of selected items and instantaneous status-data reports, which can be sorted in several formats and limited to high and low ranges within categories. In addition, each package offers password protection to maintain confidentiality of payroll data and automatic handling of vacation and sick hours.

For inventory control, the recording of sales will automatically reduce inventory on hand. Also, back orders can be created and generated, and a Bill of Materials function allows automatic component updating when items are sold. Invoice processing is designed as the "front-end processor" for the accounts receivable system, supporting invoicing of labor services and goods sold. Billing information can either be printed or displayed on a video terminal. Reader Service number S46.

Disk Sort/Merge

The SORT System, from The Software Store, 706 Chippewa-square, Marquette MI 49855, provides an easy-to-use sort/merge system for sequential files. It supports user-defined file sorts and merges. Multiple operations, including user-supplied programs, can be linked into a sort-stream to accomplish complex processing sequences without operator intervention.

The DISKSORT System is composed of two programs, SORTGEN and SORT. The interactive SORTGEN program specifies file names and defines operations to be executed by SORT. All operation modules are saved as disk files and may be executed repetitively without modification. Operation



The RomWriter.

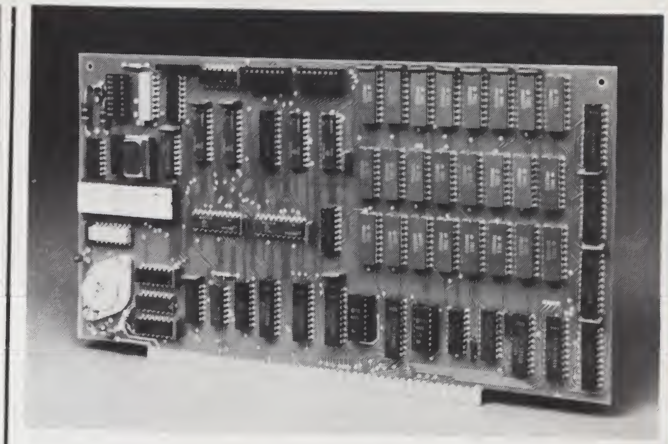
modules can be easily revised using SORTGEN. SORT allows fixed- or variable-length records to be sorted or merged on any number of fields located anywhere in the record. Each sort key can be specified for either ascending or descending sequence. It requires an 8080 or Z-80 mainframe with 48K, disk and CRT. Price is $195. Reader Service number S136.

Apple EPROM Programmer

RomWriter is an EPROM programmer designed to permit the Apple Computer owner to program 2K 2716 (5 V) EPROMs. It can be situated in any peripheral slot, except #0. EPROMs to be programmed mount in a zero-insertion force socket, and all or part of the EPROM can be programmed and its contents verified without having to move the PROM to another location. An on-board switch will turn off power to the PROM so it can be inserted or removed without having to turn off the computer. A write protect switch protects programmed EPROMs while RUNing from the RomWriter board. A $CFFF OFF switch prevents execution of this command during programming or later when RUNing.

The diskette-based software included with RomWriter permits the user to specify a start and end address in the EPROM and either a disk file name or a starting address in memory. The desired code will be BURNed, followed by a VERIFY. Additionally, existing EPROM code can be merged with desired changes to facilitate EPROM debugging. Price is $159.

Mountain Hardware, Inc., 300 Harvey West Blvd., Santa Cruz CA 95060. Reader Service number M34.



IPDI's VG100.

S-100 Video Graphics Board

The VG100 is a single-card high-density computer display system for the S-100 for text-oriented applications. The 80-character-wide VG100 has totally programmable fonts allowing any character set up to 256 characters to be defined in on-board RAM with available software, or you can create your own musical notes, logic and mathematical symbols as characters. In addition, every 8-bit character has an attribute byte, such as blink, dim, bright, blank, reverse, which allows the character to be modified up to 256 different combinations.

Graphics applications can have a combination of grays or 16 colors or combinations of both. The character field is 9 x 16, or 144 pixels, with a raster scan line of 621 pixels. The maximum vertical pixels are 704. The first line of the character field can be defined on a line for drawing out lines, underlines or mazes. The entire character field can be changed at one time, providing fast-acting animation. Adjoining character fields of any shape can be combined to create large continuous characters.

The VG100 is configured in 12K RAM memory and is selectable in three 4K blocks, i.e, 4K of screen, 4K of attribute and 4K of dot RAM. When none of these are selected, the board occupies no address space.

International Product Development, Inc., 1708 Stierlin Road, Mountain View CA 94303. Reader Service number I52.

TRS-80 Expansion Module from LNW

Reviewed by Kevin Cohan, ISI staff

An expansion interface module from LNW Research, PO Box 16216, Irvine CA 92714, provides the TRS-80 user with all the features of the regular Radio Shack expansion interface, including printer and floppy disk interfaces, 16/32K memory expansion and a serial port with full RS-232 signals. The package includes a bare board and instruction manual; case and cabinet are not provided. The user must obtain all parts, as well as a standard Radio Shack power supply, or equivalent.

Assembly, configuration and operation instructions, as well as parts lists and work sheets for parts accumulation, are included in the manual. The assembly instructions are general, assuming previous kit-building experience: The builder is expected to match the parts to their respective locations on the circuit board through the use of the schematic provided and silk-screened labels on the circuit board. This project is not for the novice.

All of the functions of the "official" Radio Shack expansion interface are provided by the LNW expansion module: a four drive disk controller; memory expansion of up to 32K; parallel printer port, a second cassette controller; and a second, user-controllable parallel port for interface to other peripherals or experiments. Available only as a $90 option on the Radio Shack interface, an additional serial I/O port with full RS-232 signaling is included in the LNW design. This port is configurable to any standard interconnection, suitable for remote terminals, modems or serial printers with or without handshaking. A mod is available to convert this to a 20 mA current loop port for driving a Teletype.

Program listings in both BASIC and machine code for printer drivers are provided to switch LLIST and LPRINT printer output from the standard parallel to the serial port. Instructions are also given to hard-wire the serial port to replace the parallel port, enabling the user to use a serial printer with all standard TRS-80 software without the necessity of running the driver programs every time the system is used. Installing a switch permits instant parallel/serial conversion; a fair amount of user modification of the circuit board is required for this setup.

A machine code listing is also provided to allow the computer to emulate a standard CRT terminal. Though jumpers determine the configuration of the serial port, switches could be substituted with a little effort. If using a Radio Shack power supply, the user might also consider installing an on/off switch.

Modular design of the circuitry permits the user to construct only the modules needed or, for the user on a tight budget, to start with one section, such as the 16/32K memory expansion, and add more modules as the money for additional parts becomes available. However, the instruction manual does not give any specifics on building individual sections; this will have to be determined from careful study of the schematics. Price is $69.95. Reader Service number L26.

TBS Software

The Bottom Shelf, PO Box 49104, Atlanta GA 30359, has announced the release of the following three programs for the TRS-80:

System Doctor—a utility program that checks the entire computer system, including ROM, RAM, video memory and display, cassette recorder's speed, volume and distortion and printer functions and records the results on tape, disk or screen. Price is $28.50.

BASIC Toolkit—an aid in BASIC language programming that provides the following features: Variables Map, GOTO X REF, Recall, Merge, Test Memory, Search Memory. It works with both disk- and cassette-based machines, 16, 32 or 48K. Price is $19.80.

Information System—an in-mem data base manager that allows up to ten fields with up to 40 characters per field and up to 200 characters total per record. It requires at least 16K and is operator programmable. You can program your own printouts to any format to accommodate Rolodex cards, summary listings or index-card-type filings. Price is $24.50. Reader Service number B44.

CP/M Software

Structured Systems Group, 5204 Claremont Ave., Oakland CA 94618, announces two software releases for CP/M-based microcomputer systems: Statement of Changes in Financial Position (SCFP) and Letteright.

SCFP is an enhancement of SSG's General Ledger accounting software package and automatically produces two statements: the Sources and Uses and Changes in Components of the Working Capital statement. The subsystem is selected from the operator menu and is designed to require no operator input at statement time. Provisions are included to break out and label unusual transactions, as specified by the user. Setup requires only entry of non-cash expense accounts and their related contra-asset accounts.

Letteright handles typical office correspondence needs, such as creating a single letter or document, or many documents, and inserting values that "customize" each letter to the recipient. It will read names and addresses from any SSG NAD Name and Address file, writing those names and addresses in the document, as well as on the envelope. Reader Service number S137.

Microtek's Printers

The MT-80 series printer is a 125 cps, 80- and 120-column bidirectional printer that supports the full uppercase and lowercase 96-character ASCII set in three software-selectable fonts (5, 10 and 15 cpi) on the original plus three copies. The microprocessor-controlled printer contains a 240 character buffer, with additional data buffers to 4K optionally available in 1K increments. A comprehensive self-diagnostic program is automatically run on power up. The printer has no duty cycle limitations. Life expectancy of the print head is 100 million characters. Mean time between failures is one million lines. The unit weighs 22 pounds and measures 7.3 × 17.7 × 14.8 inches.

The MT-80P parallel interface printer.

The pin feed paper-handling system can be adjusted to accept fan-fold forms varying from 4.5 to 9.5 inches wide. Form length is software programmable in one-line increments. The vertical format unit features top-of-form control, up to ten vertical tab settings and a skip-over-perforation capability. Paper can be loaded from the bottom or rear. The MT-80P Centronics-compatible parallel interface version is $750; the MT-80S serial (RS-232) version is $835.

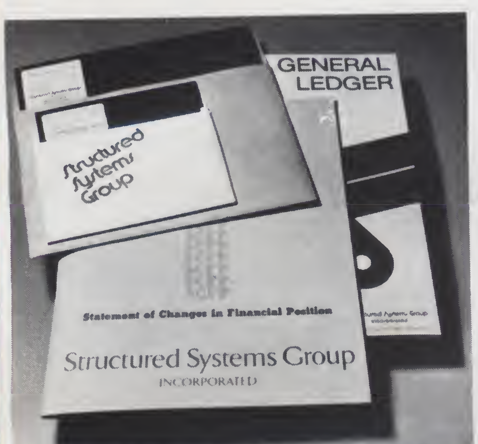
Microtek, Inc., 7844 Convoy Court, San Diego CA 92111. Reader Service number M139.

Gin Rummy Program

Looking for a formidable gin rummy opponent? Gin Rummy 2.0, from Manhattan Software, Inc., PO Box 5200, Grand Central Station, New York NY 10017, will challenge a good player and beat the average player more often than it loses.

The game program remembers its opponent's plays, adjusts its own strategy in response, allows the player to rearrange his hand and keeps score to game level or carries it over. The program checks each discard against its hand and decides whether to pick it up or draw from the deck. It will knock with ten points or less.

After player or program knocks, the program checks both hands for points and calculates a net score, including bonuses for gin or undercutting. Possible layoffs are examined and made, if proper, and player layoffs are allowed. The program will run on the TRS-80 Level II 16K. Price is $14.95. Reader Service number M137.



SCFP software.

SSG's Letteright.

Data Base Management System

Micro Data Base Systems, Inc., PO Box 248, Lafayette IN 47902, is offering a sophisticated network data base management system (DBMS) for microcomputers. The software is written in machine language and is available for the Z-80 CPU. Micro Data Base provides a full network capability and generalizes some features of the CODASYL approach, that is, instead of restricting a set relationship to be one to many, Micro Data Base permits many to many set relationships. A record type can be both the owner and member of a set relationship. Full data

The VersaWriter with Apple II.

base security is maintained by providing read and write access levels for all record types, items and set relationships.

By using data base software to produce applications systems, you can significantly reduce development time and increase flexibility. Instead of having to do extensive recording for new reports, you only need to use a small data extraction module. A common data base requires that no data be duplicated in different files and that different applications be supported in the one data base.

DBMS routines are callable from host languages and have I/O and host language interface routines isolated for easy adaption to user host language/operation system combinations. Interfaces are available for North Star, CP/M and TRS-80 operating systems. Reader Service number M138.

Apple II Graphics Drawing System

The VersaWriter, a digitizer and software drawing package, provides high-resolution, mass color graphics for the Apple II. When used as a pointer, it can direct movements of objects on the video screen for game playing or creating graphics. As a digitizer, the VersaWriter inputs graphical data for analysis for flowcharts and diagrams. The user can create drawings, achitectural plans, schematics and graphs and store or change them as desired. Sixteen commands control movement of the cursor, permit fill-in coloring using six colors, horizontal and vertical scaling, centering on the screen, storing and recalling to and from disk.

The complete system consists of the VersaWriter drawing board, which plugs directly into the game I/O, and interface, diskette software, calibration chart and instruction manual. Users require an Apple computer with disk II, 32K of memory and Applesoft ROM. Normal retail price is $199.

Rainbow Computing, Inc., 9719 Reseda Blvd., Northridge CA 91324.

S-100 Mainframe

The S-100 Mainframe, 11-5/8 × 7 × 18 inches, is a 12-slot, actively terminated device designed to give system builders a powerful tool in a small package. It comes complete with a fan and a circuit breaker. It supports output voltages of +8 V dc at 20 A and ±16 V dc at 4 A; input may be 105, 115 or 125 V ac. The S-100 Mainframe is available in five colors—office cream, black, blue, coffee tan and silver vein—and comes with a flip-top cover design. Price is $399.95, assembled and tested.

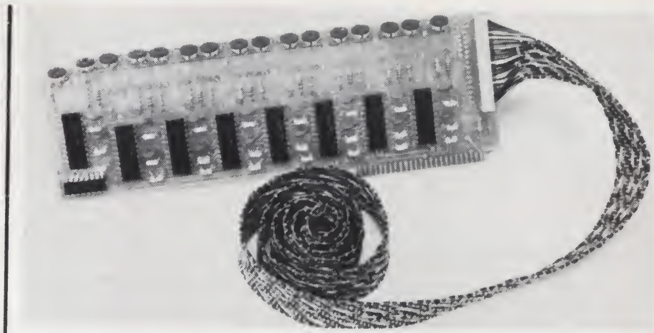
California Computer Systems, 309 Laurelwood Dr., Santa Clara CA 95050. Reader Service number C186.

Apple II Analog Output System

The AOO3 is a latched analog output card for Apple II available in 2-, 4- and 8-channel configurations. A program written in any language can set the output of a channel with a single operation. The AOO3 accepts an 8-bit quantity (0 to 255) and produces either a 0 to 10 volt output (standard) or a −5 to +5 volt range (jumper selectable).

AOO3 applications range from computer generation of musical tones to control of light or temperature in an industrial process. The AOO3, together with the AIO2 analog input system, represents a complete control and measurement facility for the Apple II ideal for home sensing and control, laboratory experiment control or industrial process control.

Interactive Structures, Inc., PO Box 404, Bala Cynwyd PA 19004. Reader Service number I49.



The AOO3 Analog Output System.

S-100 Copper-Clad Circuit Board

Now designers and hobbyists can quickly prepare custom circuit boards for their S-100-bus systems without costly and time-consuming photo-negative processing with the Model 8800R2, a positive-resist-coated, double-sided copper-clad circuit board. Form and bus compatible with the S-100 convention, this board has 100 gold-flashed, nickel-plated card-edge contacts (50 each side) on 0.125 inch centers at the lower edge. The contacts continue into the two-ounce copper fields so that no jumpers are required after etching. The board, precoated with positive photo-resist on both sides, comes with layout paper, clear Mylar film for artwork, a heavy plastic bag for etching and complete instructions.

To complete custom circuit-board fabrication, a transfer artwork kit ($2.65), etchant—16-ounce bottle of ferric chloride ($1.69) or 125-gram package of ammonium persulfate ($1.30)—and developer ($2.46) are available. The Model 8800R2 copper-clad circuit boards cost $19.95.

Vector Electronic Co., Inc., 1246 Gladstone Ave., Sylmar CA 91342. Reader Service number V8.

CPU and I/O Card with Disk Controller

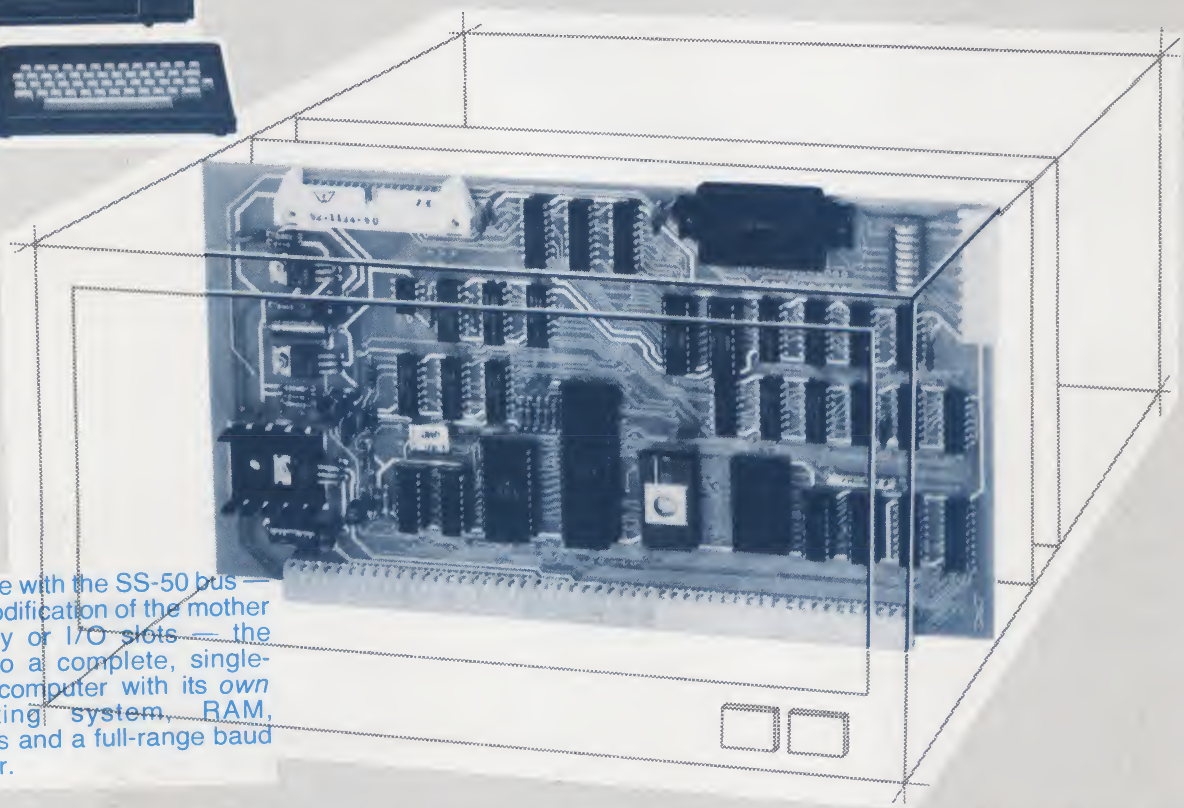
The CP/IO-1 single S-100 card provides all of the CPU and I/O

(see PRODUCTS, page 24)

CCS's S-100 Mainframe.

6809 PROCESSING POWER!

The Percom SBC/9™. Only $199.95.



Fully compatible with the SS-50 bus — requiring *no* modification of the mother board, memory or I/O slots — the SBC/9™ is also a complete, single-board control computer with its *own* ROM operating system, RAM, peripheral ports and a full-range baud clock generator.

Make the SBC/9™ the heart of your computer and put to work the most outstanding microprocessor available, the 6809.

the Mighty 6809

Featuring more addressing modes than any other eight-bit processor, position-independent coding, special 16-bit instructions, efficient argument-passing calls, autoincrement/autodecrement and more, it's no wonder the 6809 has been called the "programmers dream machine."

Moreover, with the 6809 you get a microprocessor whose programs typically use only one-half to two-thirds as much RAM space as required for 6800 systems, and run faster besides.

And to complement the extraordinary 6809, the Percom design team has developed PSYMON™, an extraordinary 6809 operating system for the SBC/9™.

PSYMON™ — Percom SYstem MONitor

Although PSYMON™ includes a full complement of operating system commands and 15 externally callable utilities, what really sets PSYMON™ apart is its easy hardware adaptability and command extensibility.

For hardware interfacing, you merely use simple, specific device driver routines that reference a table of parameters called a Device Control Block (DCB). Using this technique, interfacing routines are independent of the operating system.

The basic PSYMON™ command repertoire may be readily enhanced or modified. When PSYMON™ first receives system control, it initializes its RAM area, configures its console and then 'looks ahead' for an optional second ROM which you install in a socket provided on the SBC/9™ card. This ROM contains your own routines that may alter PSYMON™ pointers and either subtly or radically modify the PSYMON™ command set. If a second ROM is not installed, control returns immediately to PSYMON™

- Provision for multi-address, 8-bit bidirectional parallel I/O data lines for interfacing to devices such as an encoded keyboard.
- A serial interface Reader Control output for a cassette, tape punch/reader or similar device.
- An intelligent data bus: multi-level data bus decoding that allows multiprocessing and bus multiplexing of other bus masters.
- Extended address line capability — accommodating up to 16 megabytes of memory — that does not disable the on-board baud rate clock or require *additional* hardware in I/O slots.
- On-board devices which are fully decoded so that off-card devices may use adjoining memory space.
- Fully buffered address, control and data lines.

The SBC/9™, complete with PSYMON™ in ROM, 1K of RAM and a comprehensive users manual™ costs just $199.95.

™ trademark of Percom Data Company, Inc.

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PERCOM DATA COMPANY, INC.
211 N. KIRBY GARLAND, TEXAS 75042
(214) 272-3421

✓ P82

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Percom '*peripherals for personal computing*'

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Welcome to Percom's Wide World

SS-50 Bus LFD-400™ and LFD-800™ Systems

Each LFD mini-disk storage system includes:

- drives with integral power supplies in an enamel-finished enclosure
- a controller/interface with ROM operating system plus extra ROM capacity
- an interconnecting cable
- a comprehensive 80-page users manual

P67

Low-Cost Mini-Disk Storage in the Size You Want.

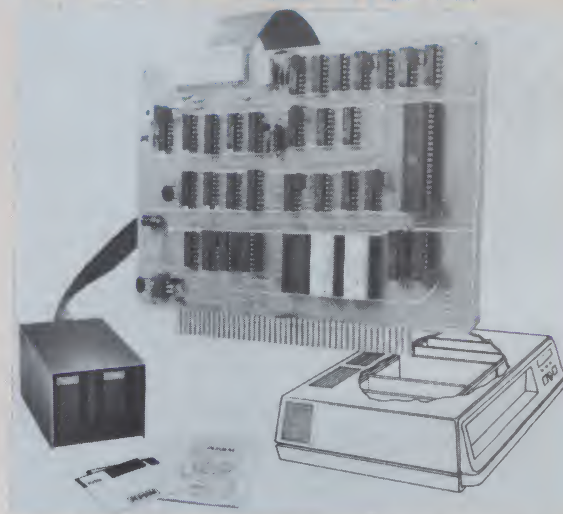
Percom LFD mini-disk drive systems are supplied complete and ready to plug in the moment they arrive. You don't even have to buy extra memory. Moreover, software support ranges from assembly language program development aids to high-speed disk operating systems and business application programs.

The LFD-400™ and -400EX™ systems and the LFD-800™ and -800EX™ systems are available in 1-, 2- and 3-drive configurations. The -400, -400EX drives store 102K bytes of formatted data on 40-track disks, and data may be stored on either surface of a disk. The -800, -800EX drives store 200K bytes of formatted data on 77-track disks.

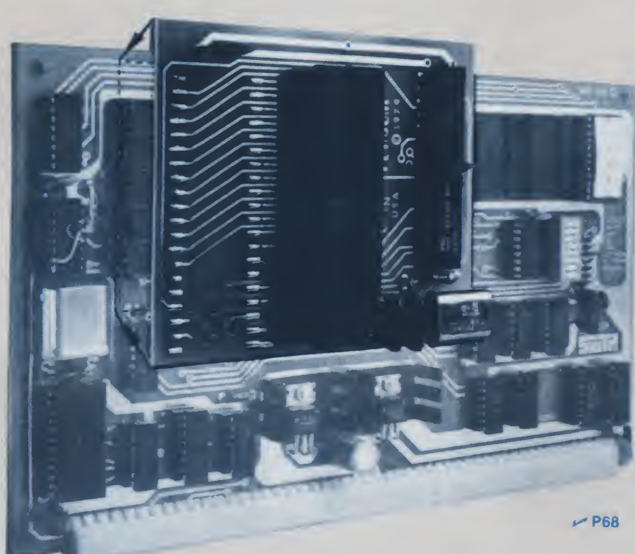
The LFD-1000™ systems (not pictured) have dual-drive units which store 800K bytes on-line. The LFD-1000™ controller accommodates two drive systems so that a user may have as much as 1.6M bytes on-line.

Mini-disk storage system prices:

MODEL	1-DRIVE SYSTEM	2-DRIVE SYSTEM	3-DRIVE SYSTEM
For the SS-50 Bus:			
LFD-400™	$ 599.95	$ 999.95	$1399.95
LFD-800™	895.95	1549.95	2195.95
For the EXORciser* Bus:			
LFD-400EX™	$ 649.95	$1049.95	$1449.95
LFD-800EX™	945.95	1599.95	2245.95
LFD-1000™	(dual) $2495.00	(quad) $4950.00	—



EXORciser Bus LFD-400EX,™ -800EX™ Systems*



P68

Upgrade to 6809 Computing Power. Only $69.95

Although designed with the SWTP 6800 owner in mind, this upgrade adapter may also be used with most other 6800 and 6802 MPUs. The adapter is supplied assembled and tested, and includes the *6809 IC, a crystal, other essential components and* user instructions. Restore your original system by merely unplugging the adapter and a wire-jumpered DIP header, and re-inserting the original components. Also available for your upgraded system is PSYMON™ (Percom SYstem MONitor), the operating system for the Percom 6809 single-board computer. PSYMON™ on 2716 ROM costs only $69.95. On diskette (source and object files), only $29.95.

Data Terminal & Two-Cassette Interface — the CIS-30+

P69

- Interface to data terminal and two cassette recorders with a unit only 1/10 the size of SWTP's AC-30.
- Select 30, 60 or 120 bytes per second cassette interfacing; 300, 600 or 1200 baud data terminal interfacing.
- Optional mod kits make CIS-30+ work with any microcomputer. (For MITS 680b, ask for Tech Memo TM-CIS-30+-09.)
- KC Standard/Bi-Phase-M (double frequency) cassette data encoding. Dependable self-clocking operation.
- Ordinary functions may be accomplished with 6800 Mikbug* monitor

Prices: Kit, $79.95; Assembled, $99.95. Prices include a comprehensive instruction manual. Also available: Test Cassette, Remote Control Kit (for program control of recorders), IC Socket Kit, MITS 680b mod documentation and Universal Adapter Kit (converts CIS-30+ for use with any computer).

of 6800 Microcomputing.

6800/6809 SOFTWARE

System Software

6800 Symbolic Assembler — Specify assembly options at time of assembly with this symbolic assembler. Source listing on diskette $29.95

Super BASIC — a 12K extended random access disk BASIC for the 6800 and 6809. Supports 44 commands and 31 functions. Interprets programs written in both SWTP 8K BASIC (versions 2.0, 2.2 & 2.3) and Super BASIC. Features: 9-digit BCD arithmetic, Print Using and Linput commands, and much more. Price $49.95

TOUCHUP™ — Modifies TSC's Text Editor and Text Processor for Percom mini-disk drive operation. Supplied on diskette complete with source listing $17.95

Operating Systems

INDEX™ — This easy-to-use disk-operating and file management system for 6800 microcomputers is fast. I/O devices are serviced by interrupt request. INDEX™ accesses peripherals the same as disk files — new devices may be added without changing the operating system. Other features: unlimited number of DOS commands may be added • over 60 system entry points • display only those files at or above user-specified file activity level • versions available for SWTP MF-68, Smoke's BFD-68 and Motorola's EXORciser*. Price $99.95

MINIDOS-PLUSX™ — An extension of the original MINIDOS™ for LFD-400™ mini-disk systems, MINIDOS-PLUSX™ manipulates files by six-character names. Supports up to 31 files. Resident commands include Initialize, Save, Allocate, Load, Files (directory list), Rename and Delete. Supplied on 2708 ROM with a minidiskette that includes transient utilities such as Copy, Backup, Create, Pack and Print Directory. Price . . . . $34.95.

PSYMON™ — Percom SYstem MONitor for the Percom single-board/SS-50-bus-compatible 6809 computer accommodates user's application programs with any mix of peripherals **without** modifying programs. PSYMON™ also features character echoing to devices other than the communicating device, sophisticated register and memory dump routines and more. Price (on 2716 ROM) . . . . $69.95.

WINDEX™ — Described in detail elsewhere on this page.

Business Programs

General Ledger — For 6800/6809 computers using Percom LFD mini-disk storage systems. Requires little or no knowledge of bookkeeping because the operator is prompted with non-technical questions during data entry. General Ledger updates account balances immediately — in real time, and will print financial statements immediately after journal entries. User selects and assigns own account numbers; tailors financial statements to firm's particular needs. Provides audit trail. Runs under Percom Super BASIC. Requires 24K bytes of RAM. Supplied on minidiskette with a comprehensive users manual. Price . . . . $199.95.

FINDER™ — This general purpose data base manager is written in Percom Super BASIC. Works wth 6800/6809 computers using Percom LFD-400™ mini-disk drive storage systems. FINDER™ allows user to define and access records using his own terminology — customize file structures to specific needs. Basic commands are New, Change, Delete, Find and Pack. Add up to three user-defined commands. FINDER plus Super BASIC require 24K bytes of RAM. Supplied on minidiskette with a users manual. Price $99.95

Mailing List Processor — Powerful search, sort, create and update capability plus ability to store 700 addresses per minidiskette make this list processor efficient and easy to use. Runs under Percom Super BASIC. Requires 24K bytes of RAM. Supplied on minidiskette with a users manual. Price $99.95.

From the Software Works

Development and debugging programs for 6800 μCs on diskette:

Disassembler/Source Generator $30.95
Reloc'tng Disas'mblr/Segmented Text Gen $40.95
Disassembler/Trace $25.95
Support Relocator Program $25.95
Relocating Assembler/Linking Loader $55.95
SmithBUG** (2716 EPROM) $70.00

½-Price Special on Hemenway Software!

CP/68‡ disk operating system . . . . $ 49.97
STRUBAL+‡ compiler $124.97
EDIT68 text editor . . . . $ 19.97
MACRO-Relocating Assembler . . . . $ 39.97
Linkage Editor (LNKEDT68) . . . . $ 24.97
Cross Reference utility . . . . $ 14.97

P70

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‡Trademark of Hemenway Associates Company
**SmithBUG is a trademark of the Software Works Company

This programmable **VIDEO DISPLAY CONTROLLER** processes display changes **instantly in real-time**. The Electric Window™ resides completely in main memory so control is accomplished by **direct MPU access** to the character-store memory and display control registers. Peer at the screen and you look right into video display memory space while you input and manipulate text — an indispensable feature for efficient screen editing and word processing. The Electric Window™. It's worth looking into. Features include:

The Electric Window.™ Worth Looking Into. $249.95

- **Programmable CRT controller chip** that provides extraordinary versatility in software control of horizontal and vertical formatting, cursor positioning, scrolling and Start/Reset functions.
- A standard ASCII 128-unit ROM character generator which generates easy-to-read **7 x 12 dot-matrix characters with lower case descenders**. Plus . . .
- Provision for an **optional ROM** that may be programmed **for special symbols or characters**.
- Resides entirely in **2K on-board RAM** mapped into main memory.
- An optional **software driver program** called WINDEX™ that complements the fast, hardware-implemented functional capability of the controller. WINDEX™ will auto-link to PSYMON™, the monitor for the Percom SBC/9™ single board computer. The ROM version of WINDEX™ costs $39.95. The minidiskette version (with source and object files) sells for $29.95.
- **Up to 24 80-character lines** — programmable.
- Program control of **display highlighting**.
- Program **interlaced or non-interlaced scan**. P71
- Use either **standard video monitor or modified tv.**

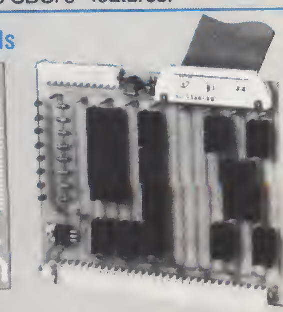
Now Available! the SBC/9™ MPU/Control Computer

(Single-Board-Computer/6809) — stands alone as a control computer, but also P82 compatible with the SS-50 bus for use as an MPU card. Includes PSYMON™ (Percom SYstem MONitor) in a 1K ROM and provides for additional 1K of ROM. Also includes 1K of RAM. Features: Super Port — provision for multi-address, 8-bit bidirectional data lines • an intelligent data bus for multi-level data bus decoding • an on-board 110-baud to 19.2 kbaud clock generator • extended address capability — to 16 megabytes — without disabling baud clock or adding hardware. And much more. Supplied with PSYMON™ and comprehensive users manual. Price . . . . $199.95.

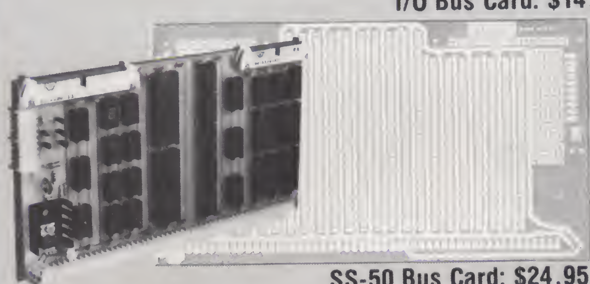
See full page ad elsewhere in this magazine for all of the SBC/9™ features.

Full Feature Prototyping PC Boards

All of the features needed for rapid, straightforward circuit prototyping. Use 14-, 16-, 24- and 40-pin DIP sockets • SS-50 bus card accommodates 34- and 50-pin ribbon connectors on top edge, 10-pin Molex connector on side edge • I/O card accommodates 34-pin ribbon connector and 12-pin Molex on top edge



I/O Bus Card: $14.95



SS-50 Bus Card: $24.95

• I/O card is 1-¼ inches higher than SWTP I/O card • interdigitated power conductors • contacts for power regulators and distributed capacitance bypassing • use wire wrap, wiring pencil or solder wiring • tin-lead plating over 2-oz copper conductors wets quickly, solders easily • FR4-G10 epoxy-glass substrate.

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BOOK REVIEWS

The Art of Software Testing

Glenford J. Myers
John Wiley & Sons, New York
1979, $17.95

I have never met a programmer whose program worked the first time (or even the fifth or sixth). Even with the advent of structured design and programming techniques, programs and systems still must be tested before they are put into service. Glen Myers has written an excellent book that helps bring the same discipline to testing that structured programming is bringing to programming.

The book opens with a self-assessment test that lets you discover how good you are at testing a simple program. Lest you be too disappointed, professional programmers average less than 60 percent when they take this test. If the test makes you doubt your testing prowess, at least take the time to read the next chapter, "The Psychology and Economics of Program Testing." On page 4, Myers writes:

> ". . . the most important single thing that one can learn about testing can be said at this point and it will take only a few pages to do so . . . everything else that can be discussed about program testing is merely supportive in nature."

That "simple thing" is Myers' definition of testing. As far as he is concerned, "testing is the process of executing a program with the intent of finding errors." I always thought I tested a program to convince myself that it worked, and I became upset when an error showed up. Mr. Myers wants me to be proud of finding errors and wants to teach me ways of finding them more efficiently. He argues effectively for adopting an engineer's approach to testing. His arguments about the economics of testing quickly eliminate any thought of taking a "brute-force" approach. Testing every conceivable combination of inputs or every possible path through a program is clearly impractical.

Besides an engineer's attitude, you need cunning to make your testing more effective; the rest of this book can help extend your cunning. Chapter 3 deals with program walkthroughs and reviews and, as such, is more appropriate to a programming organization than it is to an individual programmer at a personal computer. Applying some of this chapter's principles, however, could prove effective for individual programmers. This chapter is valuable in developing checklists of common errors that will benefit all programmers regardless of whether they can take advantage of group walkthroughs.

Chapter 4 is on designing test cases to improve their effectiveness at discovering errors. With topics on "equivalence partioning," "boundary-value analysis" and "cause-effect graphing," this chapter can be heavy going at points. I suggest skimming the details at first and concentrating on which techniques are most applicable to which situations. Then, when you come across a particular situation, go back and study the appropriate technique.

The next chapter contains the best explanation I have read on the various alternatives for testing and integrating the parts that comprise a good-sized program or system. Myers' discussions of incremental vs nonincremental testing and top-down vs bottom-up testing are lucid and convincing.

Chapter 6 describes the testing that is still necessary after individual programs have been tested. Before a system can be turned over to a user, various levels of system and function testing must be completed. The user's responsibility for acceptance testing after delivery and installation testing to ensure that the system has been properly installed at the user site are also covered in this chapter.

The chapter on debugging contains some important lessons for programmers using current microprocessors. It is often too easy to let the computer do your debugging for you. Myers makes a convincing argument that debugging is essentially an exercise best done away from the computer. Debugging is a puzzle-solving activity, and thinking will solve more puzzles than setting arbitrary breakpoints ever will.

The book concludes with a chapter on test tools and miscellaneous topics that will primarily interest professional programmers.

I recommend this book to anyone who is writing programs that will be used by someone else. Applying the lessons in this book can help provide the final touches that distinguish professional work. Even if you program strictly for yourself, this book will make a valuable addition to your library.

James V. McGee
Boston MA

Problem Solving and Structured Programming in BASIC

Elliot B. Koffman,
Frank L. Friedman
Addison-Wesley Publishing Co.
Reading MA, Menlo Park CA

Koffman and Friedman did not write this book for the amateur; their intended audience was made up of future professional computer scientists.

Their purpose was to take these professionals in hand before they developed too many bad habits; to instill discipline in the early stages when it would be less painful; to develop early habits of top-down problem solving, structured programming, crystal-clear documentation, efficient debugging and planned maintenance of completed programs. In pursuit of these objectives, they faithfully followed the format they used in their earlier book, *Problem Solving and Structured Programming in FORTRAN.*

I encountered that book when it was used as a text at the University of Maryland, and I was happy to see it reincarnated here. Some of its virtues, which improve with practice and extension to new languages, are that the authors define by illustration and example, not by lexicography. Their "flow diagrams" are much simpler than many flowcharts, but are easy to understand and to trace. The sequence in which the authors develop the subject is easy to follow.

They illustrate practically everything with three BASICs: the American National Standard (ANS) for Minimal BASIC, BASIC PLUS and the new Dartmouth BASIC. Programs and examples show how each command is handled in each of these versions; in addition, there is specific information about other BASICs, along with information on adapting programs written in one dialect to run in another.

Although the authors define "structure" operationally, it may be helpful here to point out that a structured program is organized in blocks, each block having a specific purpose, and only one path in and one out. A structured program can be written in any language, but some languages have features that make it easier. The new BASICs make it easier, but this book shows how you can do it in the older ones—and shows why you should.

Computer scientists, the book's audience, think in terms of compilers and not interpreters, and the three BASICs given most of the space in this book are compiler BASICs. This makes little difference to the user; supplement this book with information about your own operating system—input-output, file handling, storage and so on—and you're in business.

The good habits and firm discipline Koffman and Friedman advocate will work with any machine and with any BASIC. This book and a copy of your operating system manual are enough to dissolve any incompatibility between you and your computer.

Wallace Kendall
Ellicott City MD

Microcomputers and the 3 Rs: A Guide for Teachers

Christine Doerr
Hayden Book Co.
Rochelle Park NJ, 1979

Famed psychologist B. F. Skinner once said that "any teacher who can be replaced by a machine probably should be." Christine Doerr thinks that machines should be in the classroom, helping those irreplaceable teachers. Doerr spent an entire graduate program, including work with the Hewlett-Packard people, developing and investigating the classroom use of microcomputers. Bringing this effort to a culmination in this book, Doerr presents a collection of down-to-earth advice for teachers who want to bring their schools in-

(see REVIEWS, page 190)

LETTERS TO THE EDITOR

Quality Counts

All this stink about *Kilobaud Microcomputing*'s cover changes! It's the *content* of a magazine that counts, not the cover!

I see nothing wrong with the changes that have been made. It takes little, if any, real effort to flip a page to look at the table of contents. As far as your polysyllabic name is concerned, there are many other excellent magazines with polysyllabic titles (e.g., *Scientific American, National Geographic, Psychology Today).*

So what's the big deal! I'll gripe when the quality of your magazine's content drops. Until then, keep up the good work.

Richard T. Hamper
Euclid OH

Samples . . . Savors

I enjoyed James Downey's article in the December 1979 issue on the Intersil 6100. My first venture into the world of computers was with a sampler kit, as he described. I set it aside in favor of a TRS-80 about 18 months ago, but Mr. Downey's article rekindled the old flame for the PDP-8 instruction set, and I revived the unit. Thanks to your fine magazine and Mr. Downey's article, I will once again enjoy programming an easy and fine CPU.

Peter E. Noeth
San Jose CA

201Cs, BPSs, QAMs, etc.

In commenting (December 1979) on an article from the October 1979 issue of *Microcomputing*, Lenny Foner refers to some technical details concerning the Bell System 201C modem. He states that the modem uses 12 phases and two amplitude levels. The Bell 201C, as did its ancestors in the 201 family, uses differential 4-phase modulation and no amplitude modulation.

Mr. Foner says we manage four bits per signal element (baud). Again, not so—only two bits. The 201 uses a 1200 baud, 2-bit-per-baud scheme resulting in a bit rate of only 2400 bps. Dibit pairs 00, 01, 10, 11 are encoded into tail-to-head epoch angle changes of 45, 135, 315 and 225 degrees, respectively.

Bell can achieve 9600 bps as can others, but Bell uses the 209A modem, which uses QAM (quadrature amplitude modulation).

Speaking from some years of experience in Bell System Datec organizations, I sincerely hope Mr. Foner never has to get 12 phases and two levels through anything.

R. F. Raasch
Big Bend WI

Still More on Morr

When you use the program in David Morr's "Teleprinter Output for TRS-80" (August 1979, p. 38) with a non disk-based system having more than 16K, three changes must be made.

1. Change 7EA5 (76) to (C3)
2. Change 7EA6 (FF) to (E7)
3. Change 7EA7 (FF) to (00)

This amounts to a jump back to BASIC, 00E7H, which will not happen with the expansion interface turned on. The origin can then be changed to your desired location in memory.

To have your printer print what would normally be output to the screen:

1. POKE 16414,168
2. POKE 16415,126

To exit this mode:

1. POKE 16414,88
2. POKE 16415,4

With the 168D equal to A8H and 126D equal to 7E, 7EA8 is the origin of the line printer routine.

Keith W. Sherwin
Brandon, Manitoba
Canada

Expansion

I enjoyed the articles by Allan Domuret on expanded TRS-80 disk operations (October and November 1979). Part 2 was especially interesting since I had already disassembled the Microchess loader and written a machine-language program to make a backup copy exactly like the original. Mr. Domuret did, however, overlook one problem in placing the chess program on disk. In systems such as NEWDOS and TRSDOS 2.2, in which a keyboard debounce routine has been included, a nasty problem occurs. Microchess uses the system's keyboard input routine at 002BH. This routine expects the keyboard driver DCB to be available starting at location 4015H. The driver address in locations 4016H and 4017H in the above-mentioned systems points to an area in the middle of the chess program. The results are disastrous!

I suggest that anyone trying to use the procedure described in the November issue modify the move routine in Table 1 to that in Fig. 1. This change will cause the keyboard input routine to call the keyboard driver in ROM (i.e., the change will not hurt Microchess because there is so little input.

Donald G. Crawford
Phoenix AZ

```
77E1: F3          DI
77E2: 21 00 65    LD    HL,6500
77E5: 11 C0 40    LD    DE,40C0
77D8: 01 E0 0E    LD    BC,0EE0
77EB: ED B0       LDIR
77ED: 21 E1 73    LD    HL,73E1
77F0: 11 00 3C    LD    DE,3C00
77F3: 01 FF 03    LD    BC,03FF
77F6: ED B0       LDIR
77F8: 21 E3 03    LD    HL,03E3
77FB: 22 16 40    LD    (4016),HL
77FE: C3 FD 41    JP    41FD
```

Fig. 1.

OSI Coverage

I have been enjoying this publication since issue No. 1 and find the new format much better and more informative. However, as an OSI system owner, I find very little to read about this system.

Nelson G. Bailey
Powhattan VA

With the exception of TRS-80 articles (most of these are being published in 80-Microcomputing) the paucity of articles published in Microcomputing on a particular system reflects a paucity of articles submitted. The manufacturers of all known microcomputer systems have been alerted (repeatedly) that we are anxious to get articles about their systems. From there on it is a matter of how interested users are in writing and how interested the manufacturer is in encouraging users to write.

We are looking for material on uses for the system, improvements, uses with accessories, business applications, software and software modifications. If your system is being shortchanged on articles, perhaps it is time you do something about it.—Wayne.

I have been a *Microcomputing* reader for a short time, but I am pleased with your coverage of the microcomputing field. I must admit, however, that the avalanche of technical material and programs on the TRS-80, PET and SWTP had left me, an OSI owner, with mixed emotions.

I had just begun feeling a little like a bastard on Father's Day when my new copy of *Microcomputing* arrived, containing John Aughey's renumberer program for OSI BASIC (January 1979 issue). I had to try it right away, and it ran just fine . . . just what I needed.

My thanks to you for producing a great magazine, and to John Aughey for his contribution to OSI.

Ralph E. Sherrick
Harrisburg PA

I have been pleased to see an increasing number of OSI articles in *Microcomputing*. The video article by Richard Lary (December 1979) was helpful, and I also enjoyed Charles Curley's January 1980 evaluation of the C1P MF. However, several additions to these articles might help your readers.

Reverse video can also be implemented easily on the 600 board by adding an SPST switch across pins 4 and 6 of U70. It's best to run jumpers to the nearest protopad and then shielded cable off from those (this keeps down stray video signals).

The evaluation of the 1P MF contained two errors. First, the conversion from a C1P to a C1P MF requires the addition of a 610

board 8K-RAM ($299 rather than $138). Second, several companies now sell C1P software:

Aardvark Technical Services
1690 Bolton
Walled Lake MI 48088

Mountain Software
25600 Village Circle
Golden CO 80401

Bill's Micro Services
210 S. Kenilworth
Oak Park IL 60302

Structured Program Designers and
Dwo Quong Fok Lok Sow
371 Broome St.
New York NY 10013

Aardvark and Bill's also sell instructions on hardware conversions. A final hint: if you use their conversion to 600 baud, do the switching on-board with a DIP relay (Radio Shack 275-215) instead of bringing the wiring off the board. My Superboard II wouldn't run with those leads installed, and the use of the relay opens up some clever possibilities for hardware control of baud rate.

Jerry D. Cohen
E. Lansing MI

IDS Change

This letter refers to Sherman P. Wantz's article, "Inexpensive TRS-80 Printer Interface," in the October 1979 issue.

I, too, have used the Small System Hardware TRS-232 to match my TRS-80 to a printer. The IP-125 by Integral Data Systems has software-controllable print pitch. The problem I had was that the printer would not respond to programmed calls for pitch changes unless 128 decimal was added to the code. After two inquiries to Small System Hardware, I finally got the answer that cleared up the problem: change the eighth data element in line 1920 of the TRS-232 software from 32 to 01. Now the IP-125 responds to ASCII control codes per the IDS IP-125 owner's manual instructions.

Rik Karlsson
Oakton VA

More Power

I've just finished Ron Cowart's article (October 1979, p. 72) on adding memory and Level III to the TRS-80. I hope that you'll print more technical articles on the Radio Shack system because the Shack doesn't seem to want to share any technical information.

I'd like to caution readers who are attempting the memory upgrade about one omission in the article. The main processor board of each computer is marked with a number and a letter for the board version. The DIP shunt or switch at Z-3 must be programmed according to the board version. The G board must have an open line at pin 1,16. Also, for A boards the open pins are 1,14 2,13 6,9 7,8. The article mentions the configurations for a D board, so I assume that it works, but according to my copy of the TRS-80 service manual, the Z-3 shunt must be open at 1,16 6,10 8,9 for operation on a D board. This information is from the Radio Shack service-manual addendum for 16K RAM expansion (Cat. No. 26-1101).

Dennis R. Solomon
Des Moines IA

PRODUCTS

(from page 18)

facilities required to construct a disk-based microprocessor development system, business or hobbyist computer system. This 8080A-based card features fully vectored interrupts, five programmable interval timers, 24 parallel I/O lines, RS-232 serial terminal port at 100 baud to 76 kilobaud and an RS-232 pseudo-serial port for printer interface. On-board EPROM (2708 or 2716) with power on vectoring allows user memory to reside from 0000H to DFFFH.

Disk I/O supporting IBM 3740 soft-sectored format is provided for up to four 8 inch or 5¼ inch drives, and auxiliary software-driven cassette I/O circuitry is included on the board. All resident I/O devices may be accessed either in I/O space or as memory locations allowing for optimal program I/O access.

A CP/M bootstrap and B10S EPROM (complete with source listing) are included with the standard system, and custom configurations are available on special order. The CP/IO -1 typically requires 8 V at .8 A, + 15 V at .15 A and − 15 V at .05 A. Price is $499.

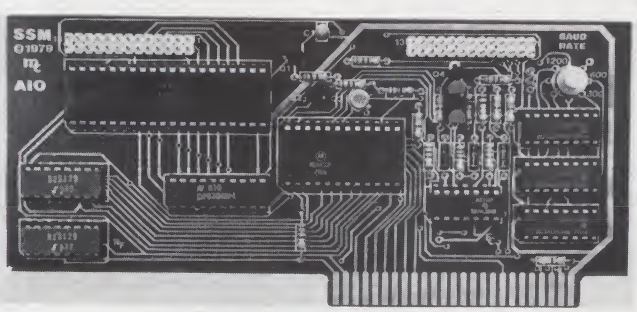
Arkon Electronics, 409 Queen Street West, Toronto, Ontario Canada, M5V 2A5. Reader Service number A118.

Apple Serial and Parallel Interface

The AIO Serial and Parallel Apple Interface allows maximum flexibility for interfacing an Apple II with peripherals, such as printers, plotters, terminals, modems and other computers. The software programmable serial interface uses the RS-232 standard and includes three handshaking lines. A rotary switch selects nine standard baud rates. On-board firmware provides a driver routine, so the user won't need to write any software to utilize the interface.

The AIO's parallel interface features software programmable I/O ports with enough lines to handle two printers simultaneously with handshaking control. The manual includes a software listing for controlling parallel printers, and a parallel driver routine is available in firmware as an option.

SSM, 2116 Walsh Ave., Santa Clara CA 95050. Reader Service number S108.



AIO Serial and Parallel Apple Interface.

Having trouble with advertisers or products? Please write complete details to firm, and send a copy to Wayne Green, *Kilobaud Microcomputing*, Peterborough NH 03458. Be polite, no matter how badly you're shafted.

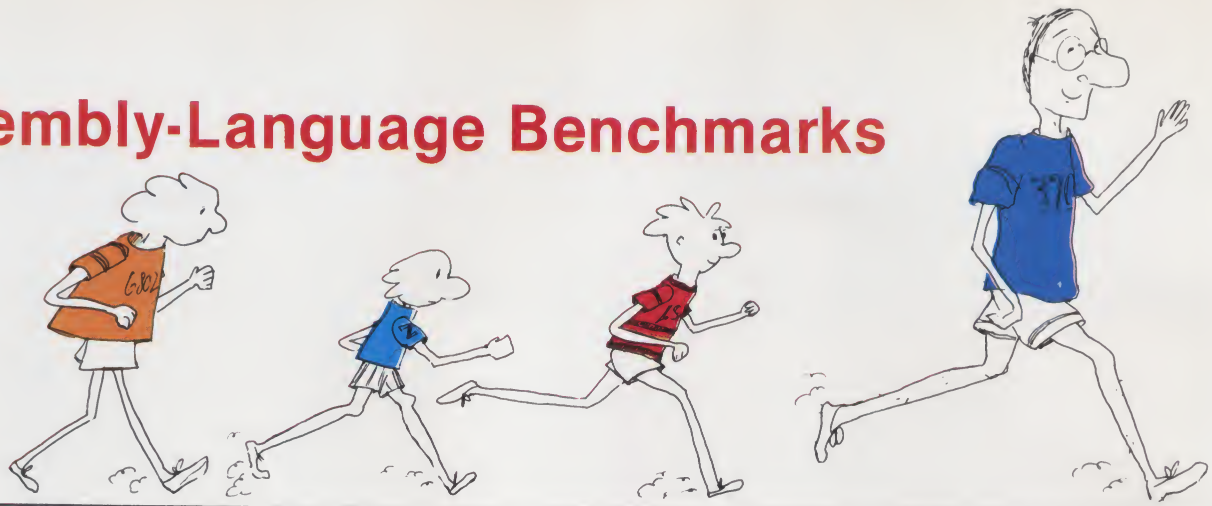
Pet Word-Processing Program

Now you can turn your PET/CBM microcomputer into a word processor with Textcast, a program for preparing rough drafts, finished manuscripts, letters, invoices and data files, from Cognitive Products, PO Box 2592, Chapel Hill NC 27514. It contains 2800 bytes of machine-language subroutines, plus an executive routine in BASIC. It works with first- or second-generation machines in 8K, creates files with one recorder, edits files with two recorders or a Commodore disk and prints formatted documents with a printer at the IEEE port. The keyboard provides both upper and lowercase, and the program makes conversions for obtaining both cases on a printer.

Special features include Easy-Flow typing without hitting return and expanded screen-editing functions on the keyboard—line deletion and insertion, shifting blocks of text, paragraph reformatting for word deletions and insertions, two extra cursor keys. Printing options include right justification, line centering and underlining (or letter enhancement and reversal with Commodore printers).

Textcast is available on tape (early ROM version on one side; current ROM version on the other side) or on diskette. Tape plus manual, $60; diskette plus manual, $65; manual separately, $20. Reader Service number C185.

Assembly-Language Benchmarks



Allan Flippin
3636 W. Park Central
Orange CA 92668

The purpose of this article is to compare the popular microprocessors to each other using benchmark programs written in assembly language. The benchmarks have been chosen to represent the needs of the typical microcomputer hobbyist. Assembly language is used so that the results will truly reflect the microprocessor's performance instead of reflecting the performance of a particular BASIC interpreter.

The Benchmarks

Each microprocessor is tested with a benchmark covering each of the following areas: sequential table access, character manipulation, random table access and arithmetic processing. These areas are essential to the operation of most home computers. If they are not dealt with directly by the user, they are undoubtedly exercised by his BASIC interpreter or other system software.

I haven't dealt with input/output processing in this comparison since the efficiency of I/O operation is greatly dependent on the external hardware used for that purpose. My intention is not to compare specific computers but to compare the potential performance of the individual microprocessor CPUs.

Sequential Table Access

In order to test sequential table processing, I have chosen a table lookup benchmark. The requirement is to sequentially scan a search table (TABLE1) looking for an entry containing a particular value. If such an entry is found, the routine must get a corresponding entry from a data table (TABLE2). The benchmark routine must detect "not found" conditions, but no error processing is required.

For example, if the third entry of TABLE1 contains the value being searched for, the contents of the third entry of TABLE2 will be obtained. If TABLE1 does not have an entry that contains the value being searched for, the benchmark will branch to ERROR where processing is halted.

Most of the microprocessors tested are able to use the table lookup technique described by D. Knuth in his "Art of Computer Programming" series. This technique involves storing the value to be searched for in a dummy entry at the end of the search table (TABLE1). While scanning the table, the routine does not have to check for end of table because a match will always be made on the last (dummy) table entry. After the match has been made, the routine then determines if the match was made on the dummy entry. If so, the match is a "fake" and a branch is made to ERROR. Use of this technique can result in up to 50 percent less execution time than the conventional way of checking for end of table each time.

In coding the benchmark, the value to be searched for is ob-

```
                                *
                                *       IBM 370 TABLE LOOKUP ROUTINE
                                *
                                *       109 MICROSECONDS
                                *         8 INSTRUCTIONS
                                *        32 BYTES
                                *
                                *
004000                          START  ORG X'4000'     SET PROGRAM ORIGIN
004000: 5850 4100                      L   5,WORD      LOAD VALUE WE WANT TO SEARCH FOR
004004: 4180 4100                      LA  8,TABLE1-4  POINT TO WORD PRIOR TO SEARCH TABLE
004008: 4160 0004                      LA  6,4         LOAD NUMBER OF BYTES
00400C: 4170 4128                      LA  7,TABLNO-4  LOAD ADDRESS OF LAST TABLE ENTRY
                                *
004010: 8686 4020               SEARCH BXH 8,6,ERROR   INCREMENT POINTER AND BRANCH IF
                                *                      PAST END OF TABLE
004014: 5550 8000                      CL  5,0(8)      CHECK FOR MATCH
004018: 4770 4010                      BNE SEARCH      LOOP BACK IF NO MATCH
                                *
00401C: 5890 8028                      L   9,TABLE2-TABLE1(8)  LOAD ENTRY FROM
                                *                      CORRESPONDING DATA TABLE
                                *
                                *
                                *--------END OF ROUTINE
                                *
004020                          ERROR  EQU *
004020: 47F0 4020               END    B   END         LOOP
                                *
                                *
                                *--------DATA AREAS
                                *
004100                                 ORG X'4100'
004100: 00000000                WORD   DC  A(*-*)      CONTAINS VALUE TO BE SEARCHED FOR
                                *
004104: 0000000000000001 TABLE1 DC  F'0,1,2,3,4,5,6,7,8,9'  SEARCH TABLE
        0000000200000003
        0000000400000005
        0000000600000007
        0000000800000009
                                *
00412C                          TABLNO EQU *           END OF TABLE
                                *
00412C: 0000000000000001 TABLE2 DC  F'0,1,2,3,4,5,6,7,8,9'
        0000000200000003                               CORRESPONDING DATA TABLE
        0000000400000005
        0000000600000007
        0000000800000009
```

IBM 370 table lookup routine.

```
                     *
                     *      IBM 370 BLOCK MOVE SUBROUTINE AND CALLING SEQUENCE
                     *
                     *      1027 MICROSECONDS
                     *        13 INSTRUCTIONS
                     *        42 BYTES
                     *
                     *
                     *--------CALLING SEQUENCE
                     *
004000               START  ORG X'4000'    SET PROGRAM ORIGIN
004000: 4150 4200           LA  5,FROM     LOAD ADDRESS OF SOURCE FIELD
004004: 4160 4300           LA  6,TO       LOAD ADDRESS OF DESTINATION FIELD
004008: 45A0 4100           BAL 10,MOVE    CALL BLOCK MOVE SUBROUTINE
                     *
                     *
                     *--------END OF ROUTINE
                     *
00400C: 47F0 400C    END    B   END        LOOP
                     *
                     *
                     *--------DATA AREAS
                     *
004200               FROM   EQU X'4200'    ADDRESS OF SOURCE FIELD
004300               TO     EQU X'4300'    ADDRESS OF DESTINATION FIELD
                     *
                     *
                     *--------BLOCK MOVE SUBROUTINE
                     *
004100                      ORG X'4100'
004100: 4170 0000    MOVE   LA  7,0        CLEAR BYTE COUNTER
004104: 4180 000D           LA  8,X'0D'    LOAD EBCDIC CARRIAGE RETURN
004108: 1898                LR  9,8        PRIME R9 FOR MOVE
                     *
00410A: 4397 5000    MOVE1  IC  9,0(7,5)   LOAD A CHARACTER
00410E: 4297 6000           STC 9,0(7,6)   STORE IN DESTINATION FIELD
004112: 4170 7001           LA  7,1(7)     INCREMENT INDEX (BYTE COUNTER)
                     *
004116: 1598                CLR 9,8        DID WE JUST MOVE A CARRIAGE RETURN
004118: 4770 410A           BNE MOVE1      LOOP BACK IF NOT
                     *
00411C: 07FA                BR  10         EXIT SUBROUTINE
```

IBM 370 block move subroutine and calling sequence.

tained from a memory location. The benchmark can place no restrictions on the address of this location, since in a normal case, the value to be searched for is obtained from a character stream instead of from a fixed location. TABLE1 and TABLE2 both contain a fixed number of fixed-length entries. The entry length can be any value convenient for the microprocessor. The two tables can be located wherever convenient. The routines written for most of the microprocessors have TABLE2 directly following TABLE1, with both tables contained in a single memory page.

Character Manipulation

To test character-manipulation processing, I have chosen a block-move benchmark. The purpose of this benchmark is not simply to move big chunks of data, but instead to evaluate the microprocessor's ability to read an input character stream and produce an output character stream at the same time.

In order to meet this objective, the benchmark includes a scan of the input character stream along with the character-by-character move. The requirements are to move a stream of characters from a source field (FROM) to a destination field (TO), moving until an end-of-field character has been moved. In most benchmarks, the ASCII carriage return is used as an end-of-field character. The benchmark also determines the number of characters, including the end-of-field character, moved.

Since a block-move routine is likely to be used by many different programs, the actual block move is coded as a subroutine with the source and destination field addresses passed as parameters. The parameters can be passed to the subroutine either through registers or through fixed memory locations. These memory locations can be located wherever convenient for the subroutine. The number of characters moved is passed back to the calling routine through a register. The calling sequence is included as part of the benchmark.

The benchmark can place no restrictions on the locations of the source and destination fields. The benchmark must work for field lengths ranging from two to 255 characters, including the end-of-field character.

Random Table Access

For random-table processing, I have chosen a jump table benchmark. For this benchmark, a table entry number is obtained from a memory location (STATE). This entry number is used to obtain an entry from a jump address table (JMPTBL). For example, if STATE contains 0, the benchmark will get the first entry in JMPTBL. If STATE contains 4, the benchmark will get the fifth entry. After the entry is obtained, the benchmark branches to the address contained in the entry.

STATE and JMPTBL can be located wherever convenient for the benchmark. JMPTBL is always small enough that it can be contained in a single memory page, with STATE in the same page if necessary. Some of the jump table benchmark routines assume that STATE directly precedes JMPTBL.

Arithmetic Processing

I have chosen a multiplication benchmark to test arithmetic processing. The benchmark routine calculates double-word unsigned binary products from single-word unsigned binary multiplicands and multipliers.

```
                         *
                         *      IBM 370 JUMP TABLE ROUTINE
                         *
                         *        8 MICROSECONDS
                         *        5 INSTRUCTIONS
                         *       14 BYTES
                         *
                         *
004000                   START  ORG X'4000'    SET PROGRAM ORIGIN
004000: 5850 4100               L   5,STATE    LOAD STATE WORD
004004: 1A55                    AR  5,5        MULTIPLY BY 4
004006: 1A55                    AR  5,5
                         *
004008: 5865 4104               L   6,JMPTBL(5)  LOAD ENTRY FROM JUMP TABLE
00400C: 07F6                    BR  6          JUMP WHERE R6 POINTS
                         *
                         *
                         *--------END OF ROUTINE
                         *
00400E: 47F0 400E        END    B   END        LOOP
                         *
                         *
                         *--------DATA AREAS
                         *
004100                          ORG X'4100'
004100: 00000000         STATE  DC  A(*-*)     STATE WORD
                         *
004104: 0000400E0000400E JMPTBL DC  A(END,END,END,END,END,END)  JUMP TABLE
        0000400E0000400E
        0000400E0000400E
```

IBM 370 jump table routine.

```
                              *
                              *      IBM 370 MULTIPLY ROUTINE
                              *
                              *        5 MICROSECONDS FOR 8 BITS
                              *        2 INSTRUCTIONS
                              *        8 BYTES
                              *
                              *
004000                        START  ORG X'4000'    SET PROGRAM ORIGIN
004000: 5870 400C                    L    7,NUM1    LOAD MULTIPLICAND
004004: 5C60 4010                    M    6,NUM2    MULTIPLY
                              *
                              *
                              *--------END OF ROUTINE
                              *
004008: 47F0 4008             END    B    END       LOOP
                              *
                              *
                              *--------DATA AREAS
                              *
00400C: 00000000              NUM1   DC   A(*-*)    MULTIPLICAND
004010: 00000000              NUM2   DC   A(*-*)    MULTIPLIER
```

IBM 370 multiply routine.

The microprocessor's performance on this benchmark gives a good indication of its arithmetic capabilities since multiplication and division are the basic building blocks of all arithmetic calculations, other than simple addition and subtraction.

Since a multiplication routine is likely to be used by many different programs, the actual multiplication takes place in a subroutine. The calling program passes the multiplier and multiplicand to the subroutine through registers or memory locations as is convenient for the subroutine. The subroutine then passes the product back to the calling routine through registers. The calling sequence is included in the benchmark and obtains the multiplicand and multiplier from memory locations. The benchmark can place no restrictions on the addresses of these locations. I have utilized multiply instructions wherever possible. In these cases, the multiplication is done by using in-line code instead of by using a subroutine.

Binary multiplication, as done with pencil and paper, involves scanning the multiplier and mentally shifting the multiplicand left each time the next multiplier bit is checked. Each time a binary digit of 1 is found in the multiplier, the shifted multiplicand is added to the product that is being accumulated. In a computer, scanning the multiplier is accomplished by shifting the multiplier right in a register or memory location and then examining the bit that has been shifted out.

Notice that the product requires twice as much room as either the original multiplicand or multiplier. Also, the multiplicand requires additional storage space, as it is shifted left, in order to save the high-order bits. Double-precision addition must be used to add the multiplicand to the product.

Another way to multiply is to shift the product right instead of shifting the multiplicand left. The multiplicand is then always added to the high-order portion of the partial product. Since the multiplicand is not being shifted, it does not require additional memory or register space and the addition process need only be single precision instead of double precision.

Now, notice that the high-order portion of the product is being shifted into the low-order portion at the same time as the multiplier is being shifted out of its location. A little experimentation using pencil and paper will show that the multiplier can coexist with the low-order portion of the product in the same register or memory location. This means that the same shift process that shifts the product into its low-order portion also shifts out the next multiplier bit for examination. I have used this technique for all microprocessors requiring programmed multiplication.

The Rating System

All of the microprocessors tested are rated in three categories: execution time, ease of programming and memory utilization. Execution times are given in microseconds. These figures are arrived at by adding up the individual instruction execution times obtained from the manufacturer's data sheets. This method has two main advantages over timing with a stopwatch. One advantage is that the resulting figures are free from variations due to nonstandard clock frequencies, memory wait states, memory refresh, timer interrupts or any other system-specific problems. The other advantage is that adding up instruction execution times, although tedious, provides exact results. I have rounded all routine execution times to the nearest microsecond to simplify calculations.

The execution time calculations do not include time spent at the end of the benchmarks (an infinite loop is used as the termination of each benchmark). For the table lookup benchmark, the search tables are assumed to be 32 entries long. The execution times are calculated assuming an average of 16 comparisons before a match is found. For the block-move benchmark, a source field

```
                             ;
                             ;       LSI 11 TABLE LOOKUP ROUTINE
                             ;
                             ;         159 MICROSECONDS
                             ;           8 INSTRUCTIONS
                             ;          26 BYTES
                             ;
                             ;
000400                               .=400                 ;SET PROGRAM ORIGIN
000400: 113701 000500        START:  MOVB  @#BYTE,R1       ;LOAD VALUE WE WANT TO SEARCH
                                                           ;FOR
000404: 110137 000513                MOVB  R1,@#TABLND     ;STORE IN DUMMY ENTRY AT END
                                                           ;OF TABLE
000410: 012702 000501                MOV   #TABLE1,R2      ;LOAD ADDRESS OF SEARCH TABLE
                             ;
000414: 122201               SEARCH: CMPB  (R2)+,R1        ;CHECK FOR MATCH AND ADVANCE
                                                           ;POINTER
000416: 001376                       BNE   SEARCH          ;LOOP BACK IF NO MATCH YET
                             ;
000420: 022702 000514                CMP   #TABLND+1,R2 ;DID WE MATCH ON DUMMY ENTRY?
000424: 001402                       BEQ   ERROR           ;IF SO, GO PROCESS ERROR
                             ;
000426: 116203 000012                MOVB  TABLE2-TABLE1-1(R2),R3  ;OTHERWISE, LOAD
                                                           ;ENTRY FROM CORRESPONDING
                                                           ;DATA TABLE
                             ;
                             ;
                             ;-------END OF ROUTINE
                             ;
000432                       ERROR:
000432: 000777               END:    BR    END             ;LOOP
                             ;
                             ;
                             ;-------DATA AREAS
                             ;
000500                               .=500
000500: 000                  BYTE:   .BYTE .-.             ;VALUE TO BE SEARCHED FOR
                             ;
000501: 000 001 002 003 TABLE1: .BYTE 0,1,2,3,4,5,6,7,10,11  ;SEARCH TABLE
        004 005 006 007
        010 011
                             ;
000513: 000                  TABLND: .BYTE .-.             ;DUMMY ENTRY AT END OF TABLE
                             ;
000514: 000 001 002 003 TABLE2: .BYTE 0,1,2,3,4,5,6,7,10,11
        004 005 006 007                                    ;CORRESPONDING DATA TABLE
        010 011
```

LSI 11 table lookup routine.

length of 128 characters is assumed for execution timings.

For the multiplication benchmark, the multiplier is assumed to have the same number of 1 bits as 0 bits, since the number of 1s in the multiplier can affect the execution time. The total execution time of the multiplication benchmarks is prorated to an 8 by 8-bit multiply. This means that a 12-bit microprocessor will be rated using two-thirds of its execution time, and a 16-bit microprocessor will be rated using one-half of its execution time. At first, this seems unfair to the 8-bit microprocessors. However, if a double-precision multiply were required on an 8-bit microprocessor, it would obviously take at least twice as long as a single-precision multiply would on the same machine.

Ease of programming is a subjective category. However, a good numerical estimate can be made by counting the number of instructions required in order to code each of the benchmarks. This method is a derivative of the old rule of thumb that states that approximately the same amount of time (effort) is required in order to write a line of code regardless of the language used or the computer being programmed. In most cases, results obtained by this method correspond closely to my own perception of programming ease. Exceptions are covered in my discussion of the comparison results.

For my calculations, an instruction is considered to be a line of code that assembles into executable machine language. For some microprocessors, constants are required in order to cross memory page boundaries or do calculations with literal values. Constants used for these purposes are counted as instructions. The loop at the end of each benchmark is not counted as an instruction.

Memory utilization is measured in bytes. These figures are calculated by counting the number of bytes taken up by instructions in each benchmark. The same instructions are included in the memory utiliza-

```
                              ;
                              ;       LSI 11 BLOCK MOVE SUBROUTINE AND CALLING SEQUENCE
                              ;
                              ;        1876 MICROSECONDS
                              ;          11 INSTRUCTIONS
                              ;          30 BYTES
                              ;
                              ;
                              ;-------CALLING SEQUENCE
                              ;
000400                                .=400               ;SET PROGRAM ORIGIN
000400: 012700 000600         START:  MOV   #FROM,R0      ;LOAD ADDRESSES OF SOURCE FIELD
000404: 012701 000700                 MOV   #TO,R1        ;AND DESTINATION FIELD
000410: 004737 000500                 JSR   PC,@#MOVE     ;CALL MOVE SUBROUTINE
                              ;
                              ;
                              ;-------END OF ROUTINE
                              ;
000414: 000777                END:    BR    END           ;LOOP
                              ;
                              ;
                              ;-------DATA AREAS
                              ;
000600                        FROM=600                    ;ADDRESS OF SOURCE FIELD
000700                        TO=700                      ;ADDRESS OF DESTINATION FIELD
                              ;
                              ;
                              ;-------BLOCK MOVE SUBROUTINE
                              ;
000500                                .=500
000500: 010102                MOVE:   MOV   R1,R2         ;SAVE STARTING ADDRESS
000502: 012703 000015                 MOV   #15,R3        ;LOAD ASCII CARRIAGE RETURN
                              ;
000506: 112021                MOVE1:  MOVB  (R0)+,(R1)+   ;MOVE BYTE AND ADVANCE POINTERS
000510: 121003                        CMPB  (R0),R3       ;IS NEXT BYTE ASCII CR?
000512: 001375                        BNE   MOVE1         ;LOOP BACK IF NOT
                              ;
000514: 110321                        MOVB  R3,(R1)+      ;STORE ASCII CR IN DEST. FIELD
000516: 160201                        SUB   R2,R1         ;CALCULATE NUMBER OF BYTES
                                                          ;MOVED
000520: 000207                        RTS   PC            ;EXIT
```

LSI 11 block move subroutine and calling sequence.

```
                              ;
                              ;       LSI 11 JUMP TABLE ROUTINE
                              ;
                              ;          19 MICROSECONDS
                              ;           3 INSTRUCTIONS
                              ;          10 BYTES
                              ;
                              ;
000400                                .=400               ;SET PROGRAM ORIGIN
000400: 013700 000500         START:  MOV   @#STATE,R0    ;LOAD STATE WORD
000404: 006300                        ASL   R0            ;MULTIPLY BY 2 FOR USE AS
                                                          ;INDEX INTO JUMP TABLE
000406: 000170 000502                 JMP   @JMPTBL(R0)   ;JUMP TO ADDRESS CONTAINED
                                                          ;IN JUMP TABLE ENTRY
                              ;
                              ;
                              ;-------END OF ROUTINE
                              ;
000412: 000777                END:    BR    END           ;LOOP
                              ;
                              ;
                              ;-------DATA AREAS
                              ;
000500                                .=500
000500: 000000                STATE:  .WORD .-.           ;STATE WORD
                              ;
000502: 000412 000412         JMPTBL: .WORD END,END,END,END,END,END  ; JUMP TABLE
        000412 000412
        000412 000412
```

LSI 11 jump table routine.

```
                              ;
                              ;       LSI 11 MULTIPLY ROUTINE
                              ;
                              ;          37 MICROSECONDS FOR 8 BITS
                              ;           2 INSTRUCTIONS
                              ;           8 BYTES
                              ;
                              ;
000400                                .=400               ;SET PROGRAM ORIGIN
000400: 013700 000500         START:  MOV   @#NUM1,R0     ;LOAD MULTIPLICAND
000404: 070037 000502                 MUL   @#NUM2,R0     ;MULTIPLY
                              ;
                              ;
                              ;-------END OF ROUTINE
                              ;
000410: 000777                END:    BR    END           ;LOOP
                              ;
                              ;
                              ;-------DATA AREAS
                              ;
000500                                .=500
000500: 000000                NUM1    .WORD .-.           ;MULTIPLICAND
000502: 000000                NUM2    .WORD .-.           ;MULTIPLIER
```

LSI 11 multiply routine.

```
                    *
                    *       9900 TABLE LOOKUP ROUTINE
                    *
                    *        193 MICROSECONDS
                    *          8 INSTRUCTIONS
                    *         26 BYTES
                    *
                    *
0100                START  ORG  <0100              SET PROGRAM ORIGIN
0100: 0060 0200            MOVB @BYTE,R1           LOAD VALUE WE ARE GOING TO SEARCH FOR
0104: D801 020B            MOVB R1,@TABLND         STORE IN DUMMY ENTRY AT END OF TABLE
0108: 0202 0201            LI   R2,TABLE1          POINT R2 TO SEARCH TABLE
                    *
010C: 9072          SEARCH CB   R1,*R2+            CHECK FOR MATCH AND ADVANCE POINTER
010E: 16FE                 JNE  SEARCH             LOOP BACK IF NO MATCH
                    *
0110: 0282 020C            CI   R2,TABLND+1        DID WE MATCH ON DUMMY ENTRY?
0114: 1302                 JEQ  ERROR              IF SO, GO PROCESS ERROR
                    *
0116: D0E2 000A            MOVB @TABLE2-TABLE1-1(R2),R3  LOAD CORRESPONDING ENTRY
                    *                              FROM TABLE2
                    *
                    *
                    *------END OF ROUTINE
                    *
011A                ERROR  EQU  *
011A: 10FF          END    JMP  END                LOOP
                    *
                    *
                    *------DATA AREAS
                    *
0200                       ORG  <0200
0200: 00            BYTE   BYTE *-*                CONTAINS VALUE TO BE SEARCHED FOR
                    *
0201: 0001 0203     TABLE1 BYTE 0,1,2,3,4,5,6,7,8,9  SEARCH TABLE
      0405 0607
      0809
                    *
020B: 00            TABLND BYTE *-*                DUMMY ENTRY
                    *
020C: 0001 0203     TABLE2 BYTE 0,1,2,3,4,5,6,7,8,9  CORRESPONDING DATA TABLE
      0405 0607
      0809
```

9900 table lookup routine.

tion byte count as are used for the previously mentioned ease-of-programming figures.

The raw data for each benchmark in each of these categories is converted into an index that is used to calculate benchmark and category averages. This index is like a golf score; low score wins. Par equals 1 for all of the index calculations. To *obtain the index*, each item of raw data for a particular category of a particular benchmark is divided by the median of the data collected in that category and benchmark.

A median is not the same as an average. An average is obtained by adding up all the data and dividing the result by the number of items being averaged. A median is obtained by ranking the items sequentially by value and taking the value of the item which is the same distance from the top and bottom of this sorted list. If the list has an even number of items, the median is obtained by averaging the two items closest to the middle of the list.

Averages work pretty well in data samples where the values involved do not vary over a wide range. However, in samples containing wide variations of data, any one large value can change the average considerably. In this kind of sample, a median gives a better indication of the normal value in the sample. The execution time data is a prime example of a sample with widely varying values. In some cases, one of the microprocessors requires more than 50 times as much execution time as another one running the same benchmark.

The indexes obtained from the previous calculations are then used to provide microprocessor averages by category and by benchmark. In my calculations, all of the benchmarks and all of the categories have been weighed equally. I have used averages for these calculations since the sample size (3 or 4) is too small to obtain a good median, and because variation within individual microprocessors is not nearly as wide as the variation between them.

Microprocessors Tested

Nine different microprocessors have been included in my tests, along with a medium-sized mainframe computer (IBM 370-145), which was tested for use as a yardstick to measure the micros. The 370-145 was chosen as the IBM representative since it is about in the middle of IBM's combined 360/370 product line. The 370-145 instruction execution time figures are taken directly from tables in the *370-145 Functional Characteristics Manual*.

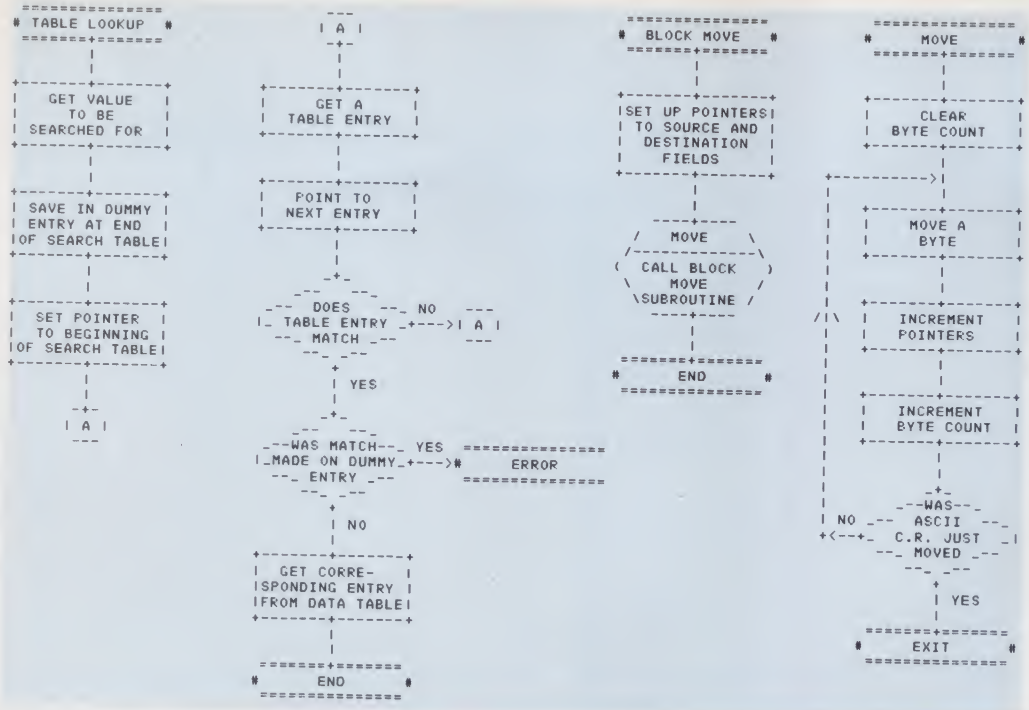
Within the microprocessors, the test includes two 16-bit models (9900 and DEC LSI-11), one 12-bit model (6100) and six 8-bit models (Z-80, 6502, 6800, 8080, 1802 and SC/MP). The LSI-11 as tested includes an optional extended arithmetic feature.

Undoubtedly, I have left out

```
                    *
                    *       9900 BLOCK MOVE SUBROUTINE AND CALLING SEQUENCE
                    *
                    *       2342 MICROSECONDS
                    *         11 INSTRUCTIONS
                    *         30 BYTES
                    *
                    *
                    *------CALLING SEQUENCE
                    *
0100                START  ORG  <0100              SET PROGRAM ORIGIN
0100: 0201 0300            LI   R1,FROM            LOAD ADDRESS OF SOURCE FIELD
0104: 0202 0400            LI   R2,TO              AND ADDRESS OF DESTINATION FIELD
0108: 06A0 0200            BL   @MOVE              CALL MOVE SUBROUTINE
                    *
                    *
                    *------END OF ROUTINE
                    *
010C: 10FF          END    JMP  END                LOOP
                    *
                    *
                    *------DATA AREAS
                    *
0300                FROM   EQU  <0300              SOURCE FIELD
0400                TO     EQU  <0400              DESTINATION FIELD
                    *
                    *
                    *------BLOCK MOVE SUBROUTINE
                    *
0200                       ORG  <0200
0200: C0C2          MOVE   MOV  R2,R3              SAVE DESTINATION FIELD ADDRESS
0202: 0204 0000            LI   R4,<0000           LOAD ASCII CARRIAGE RETURN
                    *
0206: 0CB1          MOVE1  MOVB *R1+,*R2+          MOVE A BYTE AND INCREMENT POINTERS
0208: 9111                 CB   *R1,R4             IS NEXT BYTE A CARRIAGE RETURN?
020A: 10FD                 JNE  MOVE1              LOOP BACK IF NOT
                    *
020C: 0484                 MOVB R4,*R2+            STORE ASCII CR IN DESTINATION FIELD
020E: 6083                 S    R3,R2              CALCULATE NUMBER OF BYTES MOVED
0210: 045B                 B    *R11               EXIT SUBROUTINE
```

9900 block move subroutine and calling sequence.

✓ Reader Service—see page 227



Flowcharts for table lookup and block move routines.

somebody's favorite microprocessor. In most cases, this was because I couldn't find any information regarding the microprocessor's instruction set. I would be interested in hearing from anyone having information pertaining to any of the microprocessors I haven't tested.

Now we come to the question of microprocessor clock frequency. My first idea concerning clock frequency was to use the highest possible frequency for each of the microprocessors. However, some microprocessors have reached such great speeds that expensive memory chips are required in order to keep up with them. I believe that this expense and the scarcity of these parts on the hobbyist market rule out their use for the average hobbyist. Therefore, I have chosen in each case the highest possible *clock frequency* that allows the use of memory chips in the 200–250 nanosecond access time range.

The actual clock frequencies chosen were LSI-11, 350 nanosecond micro-cycle; 9900, 3 MHz clock frequency; Z-80, 4 MHz clock frequency; 6502, 2 MHz clock frequency; 6800, 2 MHz clock frequency; 8080, 4 MHz clock frequency; 6100, 8 MHz clock frequency; 1802, 6.4 MHz clock frequency; and SC/MP, 1 microsecond microcycle.

The Flowcharts

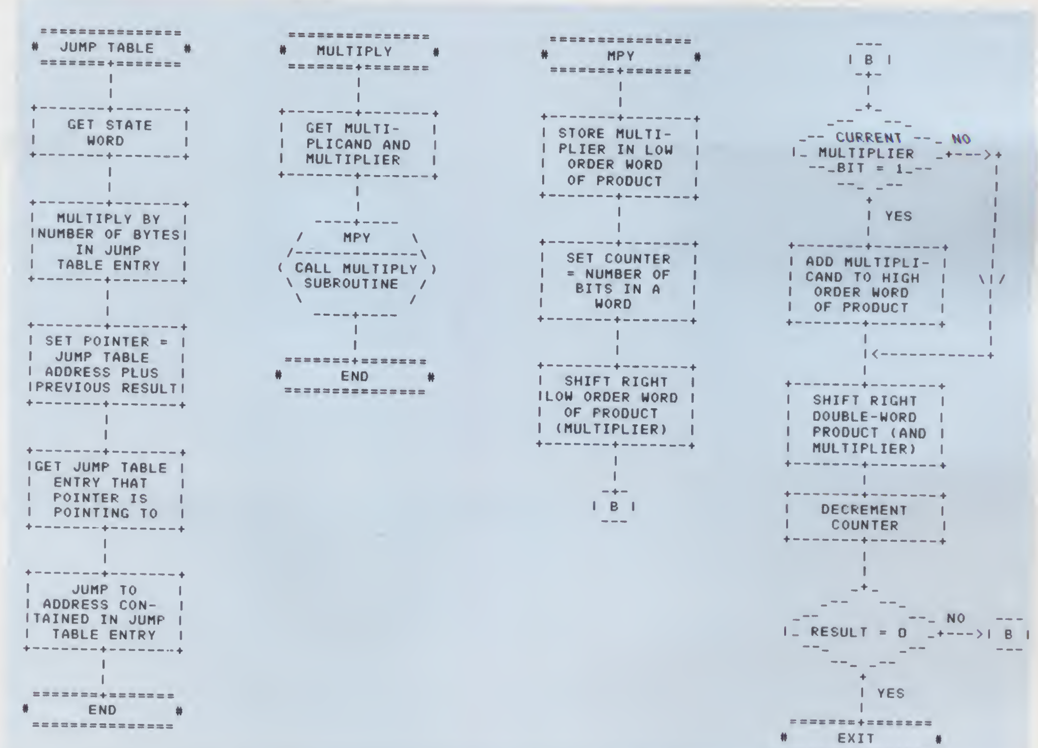
I have included flowcharts for each of the benchmarks to aid in understanding the algorithms used for the benchmarks. Since the microprocessors have such widely ranging capabilities, the actual logic used for some of the benchmark routines coded may vary from the logic shown in the flowcharts. Readers who wish to obtain assembly listings of the benchmarks should contact the author.

The Results

The ease of programming figures conflicts with my own impressions of programming ease in three cases—the Z-80, 8080 and SC/MP. All three of these microprocessors are more difficult to program than the figures indicate, because of the "special case" nature of their instructions and registers. The Z-80 is the worst offender.

Programming the Z-80 in assembly language is difficult because of the plethora of instructions available, each of them with its own idiosyncracies. For example, the jump table benchmark appears to be a good place to use one of the Z-80 index registers. However, an attempt to do so results in a slower, larger program than the alternative method using only 8080 instructions. In cases where maximum efficiency is desired using the Z-80, it seems that the solution must be coded at least three different ways in order to find the most efficient approach.

The 8080 has this same problem, although to a lesser degree because there are fewer



Flowcharts for jump table and multiply routines.

instructions and fewer registers to choose from. The 8080's main problem is that its general-purpose register pairs are not general. The HL pair is the most useful, but DE is also useful because its contents can be exchanged with HL. The BC pair is the least useful because its contents can't be exchanged with any other register pair. This lack of generality leads to a lot of data switching between registers, which complicates the programming process.

The SC/MP has a few features that make programming difficult, especially for somebody who has never programmed one before. Using the relative addressing mode, the offset is calculated, not from the first byte of the next instruction (as in other microprocessors), but from the second byte of the current instruction.

The only way the SC/MP has to make subroutine calls is by exchanging one of the pointer registers with the Program Counter. This exchange causes the microprocessor to jump one byte past the address formerly contained in the pointer register. There is no provision for branching in response to a carry or overflow condition. The only way to do this is to copy the status into the accumulator, mask the bit you are interested in and then branch according to the zero or nonzero condition in the accumulator. Altogether, the SC/MP is not really that hard to program, but it certainly is different from the other microprocessors.

EASE OF PROGRAMMING (IN NUMBER OF INSTRUCTIONS)

PROCESSOR	TABLE LOOKUP NO.	RANK	INDEX	BLOCK MOVE NO.	RANK	INDEX	JUMP TABLE NO.	RANK	INDEX	MULTIPLY NO.	RANK	INDEX
370-145	8	1	.762	13	4	.867	5	3	.588	2	1	.125
LSI-11	8	1	.762	11	1	.733	3	1	.353	2	1	.125
9900	8	1	.762	11	1	.733	4	2	.471	2	1	.125
Z80	9	4	.857	11	1	.733	11	7	1.294	15	5	.938
6502	9	4	.857	16	6	1.067	8	4	.941	17	6	1.063
6800	12	6	1.143	16	6	1.067	9	6	1.059	14	4	.875
8080	12	6	1.143	14	5	.933	11	7	1.294	19	7	1.188
6100	24	9	2.286	33	10	2.200	8	4	.941	25	8	1.563
1802	24	9	2.286	23	8	1.533	14	9	1.647	34	10	2.125
SC/MP	18	8	1.714	26	9	1.733	14	9	1.647	32	9	2.000
MEDIAN	10.5			15			8.5			16		

I'm sure one of the big questions in your mind is "Why didn't the 370-145 do any better than it did?" Even though it did achieve #1 in execution time and #1 overall, the margin is a lot narrower than was expected. The main reason seems to be that my benchmarks barely scratch the surface of the 370's capabilities.

For example, in the table lookup benchmark, while most of the microprocessors had 8-bit table entries, the 370 had 32-bit entries. Also, while many microprocessors had to be concerned with fitting the tables in a 256-byte page, the 370 program would run with table sizes of 1 million bytes or more. The same thing holds true in the block-move and jump-table benchmarks. The only place where full use of the 370's capabilities has been made is in the multiplication benchmark, where the 370-145's execution time was about 1/15 of the average microprocessor's execution time (when prorated to 8 bits).

The LSI-11 placed #1 in both ease of programming and memory utilization. In my opinion, this is due to the LSI-11's extensive addressing modes and true general-purpose registers. The 370 also has true general-purpose registers but lacks the LSI-11's addressing flexibility. I believe that the LSI-11's instruction set is the best of any of the microprocessors for hobbyist applications.

The only thing that the LSI-11 lacks is speed. Except for the multiplication benchmark, the LSI-11 placed #6 out of 10 in the execution time ratings, well behind the four popular 8-bit microprocessors.

The 9900's performance closely parallels that of the LSI-11. The 9900 also gets high marks for ease of programming and memory utilization, and low ones for speed. The 9900's instruction set is similar to that of the LSI-11, except that the 9900 has more registers and less addressing modes. Lack of speed in the 9900's case is clearly traced to its architecture, which places the general-purpose registers in external memory. This requires a memory access each time a register is referenced.

The Z-80's excellent performance in the table-lookup and block-move benchmarks is due to specific instructions in the Z-80 instruction set that deal with these tasks. The special block-move instructions didn't really help all that much, since the 8080 placed #2 in the block move without them. The Z-80 did well in the memory utilization comparison, due to its register-oriented instruction set, which includes many 1- and 2-byte instructions. The Z-80 also did well in execution time, although behind the 6502.

This brings on the question: "How can a microprocessor with a 2 MHz clock run faster than another with a 4 MHz clock?" The answer is that there

MEMORY UTILIZATION (IN BYTES)

PROCESSOR	TABLE LOOKUP NO.	RANK	INDEX	BLOCK MOVE NO.	RANK	INDEX	JUMP TABLE NO.	RANK	INDEX	MULTIPLY NO.	RANK	INDEX
370-145	32	8	1.231	42	9	1.377	14	6	1.037	8	1	.281
LSI-11	26	5	1.000	30	4	.984	10	1	.741	8	1	.281
9900	26	5	1.000	30	4	.984	12	2	.889	8	1	.281
Z80	18	1	.692	22	1	.721	13	4	.963	26	4	.912
6502	21	2	.808	31	6	1.016	18	8	1.333	32	7	1.123
6800	25	4	.962	29	3	.951	18	8	1.333	26	4	.912
8080	24	3	.923	23	2	.754	13	4	.963	31	6	1.087
6100	36	10	1.385	50	10	1.639	12	2	.889	38	8	1.333
1802	33	9	1.269	32	7	1.049	16	7	1.185	44	9	1.543
SC/MP	27	7	1.038	38	8	1.246	21	10	1.556	50	10	1.754
MEDIAN	26			30.5			13.5			28.5		

PROCESSOR	TABLE LOOKUP TIME	RANK	INDEX	BLOCK MOVE TIME	RANK	INDEX	JUMP TABLE TIME	RANK	INDEX	MULTIPLY TIME	RANK	INDEX
	EXECUTION TIME (IN MICROSECONDS)											
370-145	109	5	.813	1027	1	.621	8	1	.457	5	1	.056
LSI-11	159	6	1.187	1876	6	1.135	19	6	1.086	37	3	.411
9900	193	8	1.440	2342	8	1.417	23	8	1.314	14	2	.156
Z80	98	2	.731	1200	3	.726	15	3	.857	93	6	1.033
6502	81	1	.604	1169	2	.707	14	2	.800	85	4	.944
6800	99	3	.739	1430	5	.865	16	4	.914	87	5	.967
8080	107	4	.799	1233	4	.746	16	4	.914	130	7	1.444
6100	224	9	1.672	2824	9	1.708	21	7	1.200	154	8	1.711
1802	173	7	1.291	1963	7	1.188	35	9	2.000	268	9	2.978
SC/MP	709	10	5.291	6988	10	4.227	156	10	8.914	1242	10	13.80
MEDIAN	134			1653			17.5			90		

is more to microprocessor speed than clock frequency. The Z-80 makes a memory reference once every three or four clock cycles in most cases, whereas the 6502 (and 6800) makes a memory reference once every clock cycle. Therefore, a Z-80 running at 4 MHz makes memory references at an average rate of 1.2 MHz.

This explains the difference in execution time performance. This also explains why a 6502 needs faster memory chips than a Z-80 running at the same clock frequency. However, since the Z-80 has so many registers, fewer memory references are necessary than for the 6502. This factor brings the Z-80 execution time figures closer to those of the 6502.

The 6502's strongest point is speed. This has already been documented by recent benchmark comparisons of BASIC interpreters, which showed the 2 MHz 6502s ahead of the 4 MHz Z-80s. This speed is partly due to the 6502's two versatile index registers. When indexing, the 6502 calculates an effective address by adding the contents of an 8-bit index register to a 16-bit offset. This facilitates using a table address as the offset and varying the index register to scan the table. This capability allows the 6502 to outperform the Z-80 in the table-lookup benchmark, even though the Z-80 has special block-search instructions.

The 6502 did not do as well in the ease of programming and memory utilization figures. The main reason for this is that the 6502 only has three 8-bit registers (one accumulator and two index registers). This means that the 6502 must rely on memory more heavily than the 8080 or Z-80. This leads to longer programs since a memory reference instruction must contain one or two additional bytes in order to define the memory address referenced. Another drawback is that the 6502 has no 16-bit registers. This makes passing address parameters to subroutines difficult.

Much of what has been said about the 6502 can also be said about the 6800. The 6800 seems to be a much better microprocessor than most people give it credit for. Indeed, the poor performance of the 6800 BASIC interpreters currently available is not so much a reflection of the 6800's performance as it is a reflection of the lack of effort spent on 6800 software. When indexing, the 6800 calculates an effective address by adding the contents of the single 16-bit index register to an 8-bit offset. This scheme does not allow a table address to be used as an offset. This effectively limits the index register to simply being a pointer (like HL in the 8080).

For the table-lookup and block-move benchmarks I have used the 16-bit stack pointer to augment the index register. Notice that the code used for these benchmarks will not work if interrupts are enabled on the 6800. These benchmarks could be coded using only the index register, but with less efficiency. Even with help from the stack pointer, the 6800 placed somewhat behind the 6502 in the table-lookup and block-move benchmarks. This is due to the awkwardness of the 6800's index register. In the multiplication benchmark, the 6800 placed ahead of the 6502. The 6800's dual accumulators give it more versatility than the 6502 in this type of processing.

The 8080 places behind the 6800 in the overall figures. The 8080's strong point is memory utilization. This is due to the number of registers and register reference instructions available. Since these instructions are only 1 byte long, the resulting code takes up little memory. One reason for the gap between the 8080's and the Z-80's performance figures is the bottleneck created around the 8080's accumulator and HL register pair.

The Z-80 has sidestepped these problems by introducing index registers to relieve the HL bottleneck and bit manipulation and shifting instructions, which give the other registers some of the versatility previously reserved for the accumulator. The accumulator bottleneck is most obvious in the multiplication benchmark, which happens to be the 8080's worst benchmark.

The 6100 is an unusual microprocessor that emulates the old PDP-8 instruction set. It is a CMOS chip, which means that power consumption is low, but speed is not overwhelming. One problem the 6100 has is that each word holds two characters, but there is no charac-

PROCESSOR	TABLE LOOKUP RANK	INDEX	BLOCK MOVE RANK	INDEX	JUMP TABLE RANK	INDEX	MULTIPLY RANK	INDEX
	AVERAGES BY BENCHMARK							
370-145	3	.935	5	.955	1	.694	1	.154
LSI-11	6	.983	4	.951	2	.727	3	.272
9900	7	1.067	7	1.045	3	.891	2	.187
Z80	2	.760	1	.727	6	1.038	5	.961
6502	1	.756	3	.930	5	1.025	6	1.043
6800	4	.948	6	.961	8	1.102	4	.918
8080	5	.955	2	.811	7	1.057	7	1.240
6100	9	1.781	9	1.849	4	1.010	8	1.536
1802	8	1.615	8	1.257	9	1.611	9	2.215
SC/MP	10	2.681	10	2.402	10	4.039	10	5.851

ter addressing. This accounts for the 6100's poor showing on the block-move benchmark.

Another limitation is that the 6100 only has two registers, and only one of these can be loaded directly from memory. Considering this limitation, it is remarkable that the 6100 performs as well as it does. The 6100 has a paging scheme that complicates programming somewhat and takes up additional memory space for address constants. The 6100's best benchmark is the jump table. Its versatile indirect addressing is largely responsible.

The 6100's instruction set has a few unusual features that make it difficult to learn. Instead of a load instruction, the 6100 uses an add. This is possible because the 6100 store clears the accumulator after it stores. After you get used to these features, the 6100 is fairly easy to program.

The 1802 is another CMOS microprocessor, with the typical CMOS characteristics of low power consumption and mediocre speed. The 1802 has two major problems that are to blame for its poor showing in the comparisons: No memory access can be made unless the address is contained in one of the 16 general-purpose registers, and the only way to get an address into one of the general-purpose registers is to move it there from the accumulator, 8 bits at a time. This means that the 1802 needs to execute five instructions in order to do a subroutine call or access a byte of memory in the same manner as other microprocessors. The 16 general-purpose registers can only be used as pointers (like HL in the 8080). No indexing capability is provided.

	AVERAGES BY CATEGORY							
	EXECUTION TIME		EASE OF PROGRAMMING		MEMORY UTILIZATION		OVERALL	
PROCESSOR	RANK	INDEX	RANK	INDEX	RANK	INDEX	RANK	INDEX
370-145	1	.487	3	.586	5	.982	1	.685
LSI-11	5	.955	1	.493	1	.752	2	.733
9900	7	1.082	2	.523	2	.789	3	.798
Z80	3	.837	4	.956	3	.822	4	.872
6502	2	.764	5	.982	7	1.070	5	.939
6800	4	.871	6	1.036	6	1.040	6	.982
8080	6	.976	7	1.140	4	.932	7	1.016
6100	8	1.573	8	1.748	9	1.312	8	1.544
1802	9	1.864	10	1.898	8	1.262	9	1.675
SC/MP	10	8.058	9	1.774	10	1.399	10	3.744

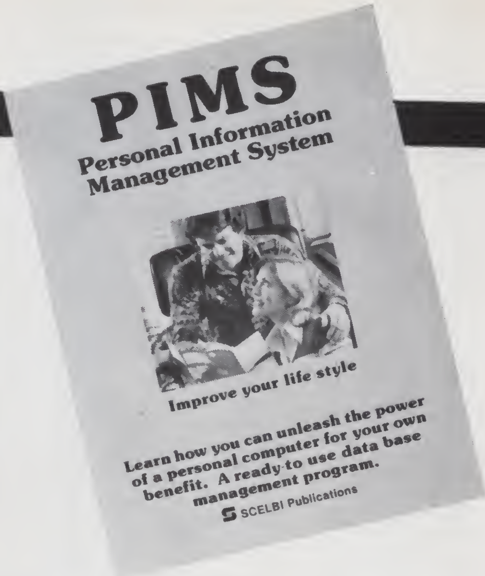
The 1802 seems to have a problem that is the opposite of the 370-145's problem in these benchmarks: The benchmarks are too complicated to represent what the 1802 was designed to do. Just what was the 1802 designed to do? Due to its low power consumption, the 1802 makes an ideal dedicated controller. In this kind of system, the programs are small enough that all of the subroutine addresses and pertinent memory addresses can be kept in the 16 general-purpose registers. After the registers are set up, they will never have to be changed. Utilizing the 1802 in this way allows for the creation of efficient code. The 1802 was not designed for use in big systems or as a number cruncher; the benchmark results have simply demonstrated this fact.

The SC/MP comes in last. It doesn't do well in any category, but its worst by far is execution time. Here is another case where the benchmarks are testing something that the microprocessor was not designed to do. The SC/MP's one claim to fame is that it is most likely the world's least expensive microprocessor. This is important for industrial uses, where microprocessors may be placed in thousands, perhaps millions, of products. However, with 6502 and 8080 prices nearing $10, there is no reason why the SC/MP should be used in any hobby applications. ■

Credits

Thanks to the following people who helped with this article: Larry Stephenson, for info on the IBM 370s; Steve Santos, for the use of his H11 (LSI-11); Jim McCord, for testing my benchmarks on his 9900; Bruce DeVries, for the use of his H8 (8080); Jeff Duntemann, for testing my benchmarks on his 1802 COSMAC; and Charles Britten, for testing my benchmarks on his SC/MP.

✓ Reader Service—see page 227



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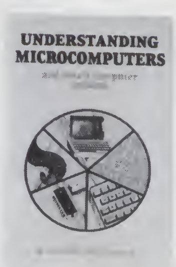

Reader Service—see page 227

Uppercase/Lowercase Utility for the TRS-80

This program solves TRS-80 uppercase/lowercase problems and offers additional features.

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After my word-processing article ("A TRS-80/Selectric Word Processor") was published in the June 1979 issue of *Kilobaud Microcomputing*, I received much correspondence that indicated that there is still a good deal of interest out there for an upper/lowercase capability for the TRS-80. Having been addicted to this microcomputer hobby for about a year and having been exposed to most of the upper/lowercase conversion instructions that appeared at one time or another in a variety of microcomputer magazines, I was under the mistaken impression that upper/lowercase modification instructions, both hardware and software, were widely and readily available. Clearly, I was mistaken.

I have also become painfully aware that many of the upper/lowercase instructions published in some magazines contained errors or suffered from other shortcomings. Among the most obvious problems were (and still are, in some cases) shift-to-type lowercase and no-shift-to-type uppercase and inverted printer output where the printer outputs uppercase for a lowercase character and vice versa. The accompanying program eliminates all of these problems.

In addition to solving the traditional upper/lowercase problems, my software program (UPRLWR) sports some additional useful features:

1. Printer Echo as an option.
2. Upper only or upper/lowercase as options.
3. Automatic line feed (as required by some printers) as an option.
4. Each of these three options can be turned on or off at will with a simple POKE xxxxx,y statement. There is no need to reload the UPRLWR program to do this.
5. Limits printer output to 64 characters per line (a carriage return is automatically inserted after the 64th character). This can also be changed with a POKE statement. The intent here is to solve the LLIST problem, in which the printer head attempts to print a long BASIC instruction line as a continuous line without a carriage return.

There is also a variety of ways to install the necessary upper/lowercase hardware components. In an effort to standardize the hardware component requirements, I wrote this program to be compatible with the hardware components as utilized by the Electric Pencil. I adopted this approach for two reasons. First, it is probably the simplest and cheapest modification to install, requiring only a 2102A memory chip, an SPDT miniature switch and a bit of wire. Second, the widespread use of the Electric Pencil suggests that its upper/lowercase hardware modification should be adopted as a standard.

Command	Option
POKE&H4018.1	Printer Echo
POKE&H4019.1	Upper/Lowercase
POKE&H401A.1	Automatic line feed

Example 1.

POKE16512.1	(instead of &H4018)
POKE16513.1	(instead of &H4019)
POKE16514.1	(instead of &H401A)

Example 2.

POKE - 32.80	(48K users)
POKE - 16416.80	(32K users)
POKE32736.80	(16K users)

Example 3.

Using UPRLWR

UPRLWR is a system program that resides in upper memory. For different memory configurations, change the ORG address in the accompanying machine-language listing to BF10H or 7F10H for 32K or 16K, respectively.

When UPRLWR is loaded, it automatically changes the vector addresses in the video and printer device control blocks (DCB) at memory locations 401E hex and 4026 hex, respectively. Before calling up BASIC, be sure to set memory size to 65290 for 48K, 48910 for 32K or 32520 for 16K.

To load the program tape while in BASIC, type SYSTEM, followed by the filename, UPRLWR. When the tape is loaded and the prompt appears, hit the slash. Disk users should call up UPRLWR/CMD or whatever filename they have selected. (Note that when punching in the program with EDTASM, tape users

Program listing.

```
          00010 ;UPRLWR/CMD, AN UPPER/LOWER CASE PROGRAM FOR
THE TRS-80 WITH ADDITIONAL FEATURES.
          00020 ;IF UPRLWR IS TO CONTROL THE LINE PRINTER
DURING PRINT OUT OF EDTASM (E.G., A/NO/LP), IT MUST BE LOADED TO
RAM BELOW EDTASM'S
          00030 ;START ADDRESS OF 6500H. THIS IS BECAUSE
EDTASM WILL OVERWRITE UPRLWR WHEN IT IS ASSEMBLING A PROGRAM AND
```

should put in an execution address of 1A19H for the BASIC reentry point, and disk users should put in an execution address of 4E00H for the DOS execution point. These addresses should be put into the last instruction line after the END instruction, as explained in the comment at the end of the instruction line.)

When UPRLWR is initially loaded, it will not do anything. It is necessary to turn the three available options on or off with a POKE command as shown in Example 1.

To turn off any of the options, POKE a 0 instead of a 1. For example, to turn off Printer Echo, POKE&H4018,0. Follow the same procedure for turning off the other options. Note: These three POKEs are identical, regardless of the TRS-80 memory configuration (16K, 32K or 48K).

Non-disk users must change these hex address references for the POKE commands to decimal form as shown in Example 2.

One of the useful features of UPRLWR is its solution to the BASIC LLIST problem. UPRLWR will automatically insert a carriage return after the 64th printed character, thus eliminating the LLIST problem in which the print head travels to the far right and pounds away on a long BASIC instruction line. This feature will be in effect at all times as long as UPRLWR is functioning. If more or less than 64 characters per line are desired, a POKE to decimal location −32, followed by the desired number of characters per line (in decimal), is required. For example, to change printer output to 80 characters per line, see Example 3.

Putting UPRLWR on Disk

TRSDOS 2.2 users should employ either the TAPEDISK or DUMP utility to put UPRLWR on disk. Follow the instructions in your TRSDOS manual. The start, end and execute addresses can be determined either by reading them directly when assembling the machine-language program with EDTASM or with a suitable disassembler or monitor such as RSM2 or TBUG.

To transfer UPRLWR to disk with NEWDOS (assuming you do not have the NEWDOS disk version of EDTASM, which supports assembly directly to disk), use the LMOFFSET routine. Read the tape in with LMOFFSET, which will, in turn, advise that the start-end-execute addresses (for 48K users) are 401E, FFF8 and 4E00, respectively. Disregard these figures and proceed as follows:

1. Load the object tape in with LMOFFSET.
2. Do not attempt to modify the load address as prompted by LMOFFSET. Bypass this LMOFFSET choice by hitting ENTER.
3. Answer "YES" to suppress the appendage. The appendage, which is normally attached to a machine-language program to relocate it to low RAM for operation, is not needed for high RAM machine-language programs.
4. Do not disable interrupts. Typically this D1 is not used unless the appendage is not suppressed.
5. Create the disk file with your choice of filename.

If you use or plan to use the Electric Secretary (ES) BASIC word processor (put out by The Peripheral People, PO Box 542, Mercer Island WA 98040), you no doubt are aware that the ES utilizes a hardware mod that differs from that required by the Electric Pencil (EP). If you are using the ES and prefer not to install the two IC chip modification as recommended in its documentation, the controlling software to make the ES compatible with the EP hardware upper/lowercase modification can be derived from UPRLWR. In other words, it is possible to use both the EP and the ES, as I do, in upper/lowercase with a common upper/lowercase hardware installation.

Perhaps it is worth mentioning that the ES, although written in BASIC as opposed to the machine-language Electric Pencil, has several capabilities that the EP does not have. For example, it has automatic hyphenation (supplemented by a hyphenation dictionary in memory), automatic insertion of salutations or name/address blocks for greatly

```
CRASH THE SYSTEM.
               00040 ;THE FOLLOWING SEEMS TO WORK OK: CHANGE LINE
160 TO <ORG 5200H>,
               00050 ;CHANGE THE LAST LINE TO, SIMPLY, <END>. THE
UPRLWR PROGRAM WILL NOT HAVE AN EXECUTION ADDRESS. ASSEMBLE UPR-
LWR AND SAVE TO DISK
               00060 ;FROM DOS, LOAD UPRLWR/CMD. IMPORTANT!! DO
NOT "RUN" UPRLWR.  WITHOUT AN EXECUTION ADDRESS, IT IS ONLY POS-
SIBLE TO
               00070 ;"LOAD UPRLWR/CMD" FROM DOS. NOTE ALSO THAT
I USED THIS TECHNIQUE WITH NEWDOS. I CAN'T PREDICT HOW IT WILL
WORK WITH DOS 2.2
               00080 ;THIS LISTING WAS COMPUTER-TYPED BY A TRS-80
 DRIVEN SELECTRIC. NOTICE THE TYPED OUTPUT IS LIMITED TO 64
               00090 ;CHARACTERS MAXIMUM PER LINE.
               00100 ;UPRLWR IS A MACHINE LANGUAGE PROGRAM FOR
TRS-80 UPPER/LOWER CASE, USING U/L HARDWARE AS REQUIRED BY THE
ELECTRIC PENCIL.
               00110 ;AFTER PROGRAM IS LOADED, TURN ON ANY OF 3
OPTIONS: POKE&H4018,1 FOR PRINTER ECHO; POKE&H4019,1 FOR U/L;
               00120 ;POKE&H401A,1 FOR AUTO LINE FEED AS REQUIRED
 BY SOME LINE PRINTERS. POKE 0 (ZERO) INSTEAD OF 1 (ONE) TO TURN
 OPTIONS OFF.
               00130 ;LINE PRINTER WILL OUTPUT 64 CHARACTERS PER
LINE. CHANGE THE '40H' IN LINE 01190 FOR SOMETHING OTHER THAN 64
CHARACTERS PER LINE
               00140 ;TO CHANGE MEMORY RESIDENCE, CHANGE THE ORG
ADDRESS IN LINE 160. 48K USERS, LEAVE AS IS. 32K USERS, CHANGE
TO 0BF10H.
               00150 ;16K USERS, CHANGE TO 7F10H
FF10           00160         ORG     0FF10H
FF10 F5        00170 VIDEO   PUSH    AF
FF11 3A1840    00180         LD      A,(4018H)
FF14 FE01      00190         CP      01
FF16 2006      00200         JR      NZ,LWROFF
FF18 79        00210         LD      A,C
FF19 C5        00220         PUSH    BC
FF1A CD3B00    00230         CALL    003BH
FF1D C1        00240         POP     BC
FF1E 3A1940    00250 LWROFF  LD      A,(4019H)
FF21 FE01      00260         CP      01
FF23 2804      00270         JR      Z,UPRLWR
FF25 F1        00280         POP     AF
FF26 C35804    00290         JP      0458H
FF29 F1        00300 UPRLWR  POP     AF
FF2A DD6E03    00310         LD      L,(IX+3)
FF2D DD6604    00320         LD      H,(IX+4)
FF30 DA9A04    00330         JP      C,049AH
FF33 DD7E05    00340         LD      A,(IX+5)
FF36 B7        00350         OR      A
FF37 2801      00360         JR      Z,NOCHR
FF39 77        00370         LD      (HL),A
FF3A 79        00380 NOCHR   LD      A,C
FF3B FE80      00390         CP      80H
FF3D D2A604    00400         JP      NC,04A6H
FF40 FE20      00410         CP      20H
FF42 3011      00420         JR      NC,ASCII
FF44 3A0838    00430         LD      A,(3808H)
FF47 E680      00440         AND     80H
FF49 2806      00450         JR      Z,CNTRL
FF4B 79        00460         LD      A,C
FF4C F640      00470         OR      40H
FF4E C37D04    00480         JP      047DH
FF51 79        00490 CNTRL   LD      A,C
FF52 C30605    00500         JP      0506H
FF55 FE40      00510 ASCII   CP      40H
FF57 DA7D04    00520         JP      C,047DH
FF5A FE60      00530         CP      60H
FF5C 3005      00540         JR      NC,LOWER
FF5E F620      00550         OR      20H
FF60 C37D04    00560         JP      047DH
FF63 E65F      00570 LOWER   AND     5FH
FF65 C37D04    00580         JP      047DH
FF68 3A1940    00590 PRINT   LD      A,(4019H)
FF6B FE01      00600         CP      01
FF6D 2014      00610         JR      NZ,NOTUL
FF6F 79        00620         LD      A,C
FF70 FE41      00630         CP      41H
FF72 380E      00640         JR      C,NOTALF
FF74 FE7A      00650         CP      7AH
FF76 300A      00660         JR      NC,NOTALF
FF78 FE5B      00670         CP      5BH
FF7A 3804      00680         JR      C,INVERT
FF7C FE20      00690         CP      20H
FF7E 3802      00700         JR      C,NOTALF
FF80 EE20      00710 INVERT  XOR     20H
FF82 4F        00720 NOTALF  LD      C,A
FF83 3A1A40    00730 NOTUL   LD      A,(401AH)
FF86 FE01      00740         CP      01
FF88 2806      00750         JR      Z,AUTOLF
FF8A CDC9FF    00760         CALL    COUNT
FF8D C38D05    00770         JP      058DH
FF90 79        00780 AUTOLF  LD      A,C
FF91 FE0D      00790         CP      0DH
FF93 280B      00800         JR      Z,NULL
FF95 FE0A      00810         CP      0AH
FF97 CAA0FF    00820         JP      Z,NULL
FF9A CDC9FF    00830         CALL    COUNT
FF9D C38D05    00840         JP      058DH
FFA0 110020    00850 NULL    LD      DE,2000H
FFA3 1B        00860 LOOP1   DEC     DE
FFA4 7A        00870         LD      A,D
FFA5 B3        00880         OR      E
FFA6 20FB      00890         JR      NZ,LOOP1
FFA8 3E0D      00900         LD      A,0DH
FFAA CDC9FF    00910         CALL    COUNT
FFAD 32E837    00920         LD      (37E8H),A
FFB0 110020    00930         LD      DE,2000H
FFB3 1B        00940 LOOP2   DEC     DE
FFB4 7A        00950         LD      A,D
FFB5 B3        00960         OR      E
FFB6 20FB      00970         JR      NZ,LOOP2
FFB8 3E0A      00980         LD      A,0AH
FFBA 32E837    00990         LD      (37E8H),A
FFBD 110030    01000         LD      DE,3000H
FFC0 1B        01010 LOOP3   DEC     DE
FFC1 7A        01020         LD      A,D
FFC2 B3        01030         OR      E
```

```
FFC3 20FB      01040          JR     NZ,LOOP3
FFC5 0E0D      01050          LD     C,0DH
FFC7 C9        01060          RET
FFC8 00        01070 BUFF     DEFB   00
FFC9 79        01080 COUNT    LD     A,C
FFCA FE0A      01090          CP     0AH
FFCC 380A      01100          JR     C,SPACE
FFCE FE0E      01110          CP     0EH
FFD0 3006      01120          JR     NC,SPACE
FFD2 AF        01130          XOR    A
FFD3 32C8FF    01140          LD     (BUFF),A
FFD6 181F      01150          JR     PRNT
FFD8 FE20      01160 SPACE    CP     20H
FFDA 381B      01170          JR     C,PRNT
FFDC 3AC8FF    01180          LD     A,(BUFF)
FFDF FE40      01190          CP     40H              ;NUMBER CHRC
TRS PER LINE
FFE1 2010      01200          JR     NZ,COUNTR
FFE3 AF        01210          XOR    A
FFE4 32C8FF    01220          LD     (BUFF),A
FFE7 2A2640    01230          LD     HL,(4026H)
FFEA C5        01240          PUSH   BC
FFEB 0E0D      01250          LD     C,0DH
FFED CD0C00    01260          CALL   000CH
FFF0 C1        01270          POP    BC
FFF1 18D6      01280          JR     COUNT
FFF3 3C        01290 COUNTR   INC    A
FFF4 32C8FF    01300          LD     (BUFF),A
FFF7 79        01310 PRNT     LD     A,C
FFF8 C9        01320          RET
401E           01330          ORG    401EH
401E 10FF      01340          DEFW   VIDEO
4026           01350          ORG    4026H
4026 68FF      01360          DEFW   PRINT
4E00           01370          END    4E00H            ;4E00H IS FO
R DISK ONLY.           TAPE USERS, REPLACE WITH 1A19H
```

simplified printout of form letters and automatic modification of printer format anywhere in the midst of text (e.g., double-to-single space and back again without stopping the printer and/or indentation of left and right margins with left and right justification as is often required for quotes or for emphasizing short paragraphs in text).

If anyone needs help in modifying the ES software to compatibility with the EP upper/lowercase hardware components, contact me direct by mail or phone.

As has already been mentioned, the upper/lowercase software option in the accompanying machine-language program (UPRLWR) requires the hardware modification as utilized by the Electric Pencil. For those of you who do not have the Electric Pencil and want a copy of the upper/lowercase hardware installation instructions, send me $2.50 to cover the cost of handling, copying and mailing for a copy. And for those of you who are not into machine-language programming, send $8.00 for a copy of the software, guaranteed to load and run. (Specify memory, 16K, 32K or 48K). If you purchase the machine-language tape, I will include a free copy of the EP upper/lowercase hardware installation instructions, if requested. ■

✓ Reader Service—see page 227

William P. Van Horn
1454 Kelchner Rd.
Bethlehem PA 18018

Income Tax Consultant

When tax time rolls around, you can agonize or computerize. This tax-preparation program was written in Digital Group Business BASIC, but it is easily converted to other BASICs.

This program will assist you in completing your 1979 tax return, particularly if you are unfamiliar with the procedures. It takes you through the 1040 form step by step.

The Program

The 1979 tax-law changes have been incorporated in the program. You will benefit most from this program if you use the 1040 (long) form and itemize your deductions. Schedules A, B and D are also included.

The program calculates your taxable income, but you must refer to the tax tables for the actual tax for your income bracket and exemptions. It is written in Digital Group Business BASIC but is easily converted to other BASICs. The program requires about 12K of memory in addition to your BASIC needs.

Although it's a long program, it is an easy matter to delete those portions that do not apply to your own tax matters. The length is determined by how much you want the program to do for you. I left out the section on energy-saving deductions, as they would have added to the length. They are easy to do and can be appended to the computer's calculations. The advantage of using this program for a single tax return would be hard (if not impossible) to discern on the basis of time saved.

It does have merit, though, and you will find that it is worth the effort to write it. You can quickly compute your tax in several different ways: If you are married you can compute it both as a single or joint return; you can itemize your deductions versus taking the standard deductions; or you can plug in different values and see how they affect the outcome to help guide you.

This program takes the drudgery out of the job and therefore gives you the incentive to do it earlier. Did you ever finish filing your taxes and discover you forgot a deduction and wonder whether it is worth doing over? Well,

Table 1.

Income	
Wages, etc.	A1
Interest income	A3
Dividends	Q1
Dividends exclusions	Q2
Dividends less exclusions	A4
State and local income tax refunds	A8
Alimony received	A9
Captial gains or losses	A5
Pension	A6
Other income	A2
Total income	A
Adjustments to income	
Moving expenses	W1
Employee business expense	W2
Interest penalty for early withdrawal	W3
Alimony paid	W4
Total adjustments	W
Adjusted gross income	W6
Medical and dental expenses	
One half insurance premiums	Y1
Medicine and drugs	Y2
One percent of adj. income	G1
Balance of ins. premiums	Y3
Doctors, dentists, nurses, etc.	Y4
Hospitals	Y5
Hearing aids, dentures, glasses, transportation	Y6
Total	Y
3 percent of adj. income	G3
Total less 3 percent	G5
Total medical and dental	J1
Taxes	
State and local income	B1
Real estate	B3
State sales	B5
Personal property	B7
Other	B6
Total taxes	B
Interest expense	
Home mortgage	C1
Credit and charge cards	C2
Other	C3
Total	C5
Contributions	
Cash	D1
Other	D2
Total	D
Casualty or theft losses	
Loss before Ins. reimbursement	E1
Ins. reimbursement	E2
Deductible loss	E4
$100 or E4, whichever is less	E5
Total losses	E
Misc deductions	
Union dues	F1
Other	F2
Total	F
Total deductions	G
Deduction exclusions	H
Deductions less exclusions	I
Taxable income	W6-I
Tax from table	T1
Amount withheld or paid	T
Capital gains or losses	
Short term	
Sales Price	L1,L3
Cost	L2,L4
Net short term gain or loss	L6
Long term	
Sales price	U1,3,5
Cost	U2,4,6
Net long-term gain or loss	U8
Total capital gains or losses	P1
One half of long-term g. or l.	P2
Short term plus one half of long term	P3
60% of line 20	K1
60% of line 21	K2
Lesser of K1 and K2	K3
P1-K3	K4
Dividends and Interest	
Dividends from Schedule B	V6,7,8
Nontaxable	V9
Total	V0
Interest from Schedule B	I1,2
Response to program queries	
Do you have any interest income?	R0$
Do you have any dividend income?	R1$
Do you have any capital gains or losses?	R2$
Do you have any adjustments to income?	R3$
Do you wish to itemize deductions?	R4$
Do you have any medial expenses?	R5$
Do you have any interest expense?	R6$
Do you have any contributions?	R7$
Do you have any casualty or theft?	R8$
Do you have any miscellaneous?	R9$
Do you wish hard copy?	M1$
Do you wish to review?	M2$
Do you have any long term capital gains or losses?	M3$

Sample run.

```
This program completes Form 1040 and Schedules A,B and D

     Enter the appropriate numbers when prompted. Prompts will
ask for one or more inputs. If you have only one input, enter
0s for the others. Hit RETURN after each input.


                         FORM 1040

Income

Line 8  Wages, salaries, tips and other ?10500
Do have any interest income ? (Y for Yes, N for No)Y
Is it over $400
?Y
            SCHEDULE B -- Interest and Dividend Income

Part I Interest income.

Interest income ?350
Interest income ?225

LINE 2  Total.(Enter on FORM 1040 line 9)           $575.00

                         FORM 1040

Line 9  Interest income ?575
Do you have any dividend income ?Y
Is it over $400 ?
?Y
                         SCHEDULE B
Part II Dividend income.

Dividend ?300
Dividend ?250
Dividend ?195

Line 4=                                             $745.00
Line 6  Nontaxable distributions ?  165
Line 8 (Subtract line 6 from line 4)=               $580.00
Enter line 8 on FORM 1040 line 10a.

                         FORM 1040

Line 10a Dividends ?580              10b Exclusions ?200
Line 10c=                                           $380.00
Line 11  State and local income tax refunds ?0
Line 12  Alimony received ?0

Do you have any capital gains or losses ? Y


            SCHEDULE D -- Capital Gains and Losses

Part I--Short-term Capital Gains and Losses.(1 year or less)

Do you have any ?
?Y
Part I Short-term Capital Gains and Losses.
Line 1  Sales price ?1500
Cost ?1200
Line 1  Sales price ?850
Cost ?1050
Line 8  Net short-term gain or loss=                $100.00

Part II--Long-term Capital Gains and losses.(1 year or more)

Do you have any ?
?Y
Line 9  Sales price ?2200
Cost ?1575
Line 9  Sales price ?3500
Cost ?3750
Line 9  Sales price ?1800
Cost ?750
Line 20  Net long-term gain or loss=              $1,425.00


Part III Summary of Parts I and II
Line 21= Combine lines 8 and 20.                  $1,525.00
Line 22a =                                          $855.00
Line 22b =                                          $670.00
                         FORM 1040

Line 14  Capital gain or loss ? (use minus sign if loss)670
Line 17 Pension ?0
Line 21 Other income ?0

Adjustments to income.

Do you have any ? (Y for Yes, N for No)
?Y

Line 23  Moving expenses ?250
Line 24  Employee business expenses ?150
Line 27  Interest penalty due to early withdrawal ?0

Line 28  Alimony paid ?0

Do you wish to itemize deductions? Y
```

```
                         SCHEDULES A & B.

Medical and dental expense.

Do you have any ?
?Y
Line 1  One half (up to $150) of Ins.premiums ?150
Line 2  Medicine and drugs ?275
Line 3  (1% of line 31 FORM 1040)=                        $117.25
Line 4  (line 2 minus line 3)=                            $157.75
Line 5  Balance of insurance not entered on line 1 ?135
Line 6  Other medical and dental expenses:
           a-Doctors, Dentists, Nurses, etc.?425
           b-Hospitals ?215
           c-Other (hearing aids, dentures, glasses, transp.)?55
Line 7  Total=                                            $987.75
Line 8  (3% of line 31 FORM 1040)=                        $351.75
Line 9  (line 7 minus line 8)=                            $636.00
Line 10  Total medical and dental expenses=               $786.00

Taxes

Line 11  State and local income taxes ?225
Line 12  Real estate taxes ?1235
Line 13  State sales tax ?165
Line 14  Personal property ?50
Line 15  Other ?0

Interest expense.

Do you have any ?
?Y
Line 17  Home mortgage ?895
Line 18  Credit and charge cards ?75
Line 19  Other ?0

Contributions.

Do you have any ?
?Y
Line 21  Cash Contributions.500
Line 22  Other than cash ?75

Casualty or theft losses.

Do you have any ?
?Y
Line 25  Loss before insurance reimbursment ?750
Line 26  Insurance reimbursment ?500
Line 27=                                                  $250.00
Line 28  Enter $100 or line 27, whichever is less ?100

Misc.deductions.

Do you have any ?
?Y
Line 30  Union dues ?175
Line 31  Other ?30

Do you wish hardcopy ?Y

                         INCOME

Line 8    Wages, salaries, tips and other.        $10,500.00
Line 9    Interest income=                           $575.00
Line 10c  Dividends=                                 $380.00
Line 11   State and local income tax refunds=          $.00
Line 12   Alimony received=                            $.00
Line 14   Capital gain or loss=                      $670.00
Line 17   Pension=                                     $.00
Line 21   Other income=                                $.00
Line 22   Total income=                           $12,125.00

RETURN to continue, please.
                   ADJUSTMENTS TO INCOME.


Line 23  Moving expenses=                                 $250.00
Line 24  Employee business expense=                       $150.00
Line 27  Interest penalty due to early withdrawal=          $.00
Line 28  Alimony paid=                                      $.00

Line 30  Total adjustments=                               $400.00

Line 31  Adjusted gross income=                        $11,725.00

RETURN to continue.
Medical and Dental expenses.

Line 1  1/2 (but no more than $150) of Ins. prem.=    $150.00
Line 2  Medicine and drugs.=                          $275.00
Line 3  1% of line 31=                                $117.25
Line 4  (line 2 minus line 3)=                        $157.75
Line 5  Bal. of Ins. prem. not entered on line 1=     $135.00
Line 6  Other medical and dental expenses.
          a-Doctors, Dentists, Nurses, etc.=          $425.00
          b-Hospitals=                                $215.00
          c-Other=                                     $55.00
Line 7  Total=                                        $987.75
Line 8  (3% of line 31)=                              $351.75
Line 9   (line 7 minus line 8)=                       $636.00
Line 10  Total medical and dental expenses=           $786.00
RETURN to continue, please.

Taxes.

Line 11  State and local income taxes=                $225.00
```

```
Line 12  Real estate taxes=                                  $1,235.00
Line 13  General sales tax=                                    $165.00
Line 14  Personal property tax=                                 $50.00
Line 15  Other=                                                   $.00

Line 16  Total taxes=                                        $1,675.00
Line 20  Total interest expense=                               $970.00
Line 24  Total contributions=                                  $575.00
Line 29  Total casualty or theft losses=                       $150.00
Line 32  Total Misc. deductions=                               $205.00

Line 40 Schedule A .... Deductions excluded? 3400
RETURN to continue, please.

                SUMMARY OF ITEMIZED DEDUCTIONS.

Line 33  Total medical and dental=                             $786.00
Line 34  Total taxes=                                        $1,675.00
Line 35  Total interest=                                       $970.00
Line 36  Total contributions=                                  $575.00
Line 37  Total casualty or theft=                              $150.00
Line 38  Total miscellaneous=                                  $205.00

Line 39  Total deductions=                                   $4,361.00
Line 40  Amount of deductions excluded =                     $3,400.00
Line 41  (line 39 minus line 40)=                              $961.00
Income less deductions ($11,725.00-    $961.00)             $10,764.00
Taxable Income=                                             $10,764.00

Enter tax from table
?842
Amount withheld= ?800
Taxable income=                                             $10,764.00
Tax from table=                                                $842.00
Taxes withheld=                                                $800.00

Amount of tax still due=                                        $42.00
```

that will never be a tough decision after you have this program.

Another feature can get as many copies of your return as you'd like if you have a printer. Even if you don't, you can copy the pertinent figures by hand. Once you have written the program you will be able to use it every year, and it really makes doing your annual tax chore more pleasant.

Operation

When you run the program you will notice that it switches from form 1040 to schedules A, B or D as is appropriate. Be alert for occasions when the program asks you to input numbers from one of the schedules to a certain line on 1040. Also note that some queries may repeat. If you have only one input in a category that asks for more than one, simply use zeros for the others. If you have more numbers than required, you must lump them together to get to the correct total.

Because of the program's length, I omitted error-correcting features, so be careful when you input data. It's a good idea to have all your figures ready before you begin, because if you make a mistake you'll have to start at the beginning. Make frequent references to the 1040 form and the sample run.

Different BASICs

This program may be easily converted to other BASICs. # is shorthand for PRINT. INPUT statements use a comma before the variable. Maybe your BASIC needs a semicolon. Line 330 is the formatting line. It formats all future lines for a field of ten numbers with dollar signs, commas and decimals to two places. This is a useful feature. You will have to use your formatting procedure.

Some BASICs use PRINT USING !!$###,.## statements. The INPUT1 command inhibits a carriage return and line feed. If your BASIC doesn't have it, just use INPUT. The OPEN (PRINTER,X) and CLOSE (PRINTER,X) statements turn the printer on and off. You will have to substitute your BASIC's commands for these functions.

Conclusion

Despite the program's length, it's easy to write and not complicated to get running. The extra time you spend writing this will be saved by the lack of debugging time needed. I printed the listing with my Selectric typewriter under computer control; it should not require debugging other than the differences in your BASIC.

I ran many sample tax programs on it including the many examples given in the IRS instruction book, and it checked out every time. Tax matters are complicated, however, so it is a good idea to double-check your results.

If you have any problems or questions, please feel free to write to me and enclose an SASE for a reply. ■

Program listing.

```
10  CLOSE (PRINTER,X)
20  REM ===== BY BILL VAN HORN 1-4-1980 =====
30  #"This program completes Form 1040 and Schedules A,B and D"
40  #" " : #" "
50  #TAB(5);"Enter the appropiate numbers when prompted. Prompts will"
60  #"ask for one or more inputs. If you have only one input, enter"
70  #"0s for the others. Hit RETURN after each input."
80  #" " : #" " : #" "
90  REM
100  #TAB(25);"FORM 1040"
110  #
120  #"Income"
130  #
140  INPUT "Line 8  Wages, salaries, tips and other ?",A1
150  INPUT "Do have any interest income ? (Y for Yes, N for No)",R0$
160  IF R0$="Y" THEN #"Is it over $400" ELSE GOTO 230
170  INPUT R0$
180  IF R0$="Y" THEN GOTO 3090
190  GOTO 220
200  #TAB(25);"FORM 1040"
210  #
220  INPUT "Line 9  Interest income ?",A3
230  INPUT "Do you have any dividend income ?",R1$
240  IF R1$="Y" THEN #"Is it over $400 ?" ELSE GOTO 340
250  INPUT R1$
260  IF R1$="Y" THEN GOTO 3210
270  GOTO 300
280  #TAB(25);"FORM 1040"
290  #
300  INPUT1 "Line 10a Dividends ?",Q1
310  INPUT "                    10b Exclusions ?",Q2
320  LET A4=Q1-Q2
330  #"Line 10c=";TAB(50);%$C?10F2;A4
340  INPUT "Line 11  State and local income tax refunds ?",A8
350  INPUT "Line 12  Alimony received ?",A9
360  #
370  INPUT "Do you have any capital gains or losses ? ",R2$
380  IF R2$="Y" THEN 390 ELSE 430
390  GOTO 2600
400  #TAB(25);"FORM 1040"
410  #
420  INPUT "Line 14  Capital gain or loss ? (use minus sign if loss)",A5
430  INPUT "Line 17 Pension ?",A6
440  INPUT "Line 21 Other income ?",A2
450  A=A1+A2+A3+A4+A5+A6+A7+A8+A9
460  W6=A-W
470  GOTO 650
480  INPUT "Do you wish hardcopy ?",M1$
490  #
```

```
500  IF M1$="Y" THEN OPEN (PRINTER,X) ELSE CLOSE (PRINTER,X)
510  #TAB(25);"INCOME"
520  #" " : #" "
530  #"Line 8    Wages, salaries, tips and other.";TAB(50);%$C?10F2;A1
540  #"Line 9    Interest income=";TAB(50);A3
550  #"Line 10c  Dividends=";TAB(50);A4
560  #"Line 11   State and local income tax refunds=";TAB(50);A8
570  #"Line 12   Alimony received=";TAB(50);A9
530  #"Line 14   Capital gain or loss=";TAB(50);A5
590  #"Line 17   Pension=";TAB(50);A6
600  #"Line 21   Other income=";TAB(50);A2
610  #"Line 22   Total income=";TAB(50);A
620  #
630  INPUT "RETURN to continue, please.",R$
640  GOTO 800
650  #
660  #"Adjustments to income."
670  #
680  #"Do you have any ? (Y for Yes, N for No)" : INPUT R3$
690  IF R3$="Y" THEN GOTO 700 ELSE 950
700  #
710  INPUT "Line 23  Moving expenses ?",W1
720  INPUT "Line 24  Employee business expenses ?",W2
730  INPUT "Line 27  Interest penalty due to early withdrawal ?",W3
740  #
750  INPUT "Line 28  Alimony paid ?",W4
760  W=W1+W2+W3+W4
770  W6=A-W
780  #
790  GOTO 950
800  #
810  IF R3$<>"Y" THEN 1290
820  #TAB(20);"ADJUSTMENTS TO INCOME."
830  #" " : #" "
840  #"Line 23  Moving expenses=";TAB(50);W1
850  #"Line 24  Employee business expense=";TAB(50);W2
860  #"Line 27  Interest penalty due to early withdrawal=";TAB(50);W3
870  #"Line 28  Alimony paid=";TAB(50);W4
880  #
890  #"Line 30  Total adjustments=";TAB(50);W
900  #
910  #"Line 31  Adjusted gross income=";TAB(50);W6
920  #
930  INPUT "RETURN to continue.",R$
940  GOTO 1290
950  #
960  INPUT "Do you wish to itemize deductions? ",R4$
970  IF R4$="Y" THEN 980 ELSE 2420
980  #"" : #""
990  #TAB(25);"SCHEDULES A & B."
1000  #" " : #" "
1010  #"Medical and dental expense."
1020  #
1030  #"Do you have any ?" : INPUT R5$
1040  IF R5$="Y" THEN 1050 ELSE 1500
1050  INPUT "Line 1  One half (up to $150) of Ins.premiums ?",Y1
1060  INPUT "Line 2  Medicine and drugs ?",Y2
1070  G1=.01*(A-W)
1080  #"Line 3  (1% of line 31 FORM 1040)=";TAB(50);G1
1090  G2=Y2-G1
1100  IF G2<0 THEN G2=0
1110  #"Line 4  (line 2 minus line 3)=";TAB(50);G2
1120  INPUT "Line 5  Balance of insurance not entered on line 1 ?",Y3
1130  #"Line 6  Other medical and dental expenses:"
1140  #TAB(10);" "; : INPUT "a-Doctors, Dentists, Nurses, etc.?",Y4
1150  #TAB(10);" "; : INPUT "b-Hospitals ?",Y5
1160  #TAB(11);
1170  INPUT "c-Other (hearing aids, dentures, glasses, transp.) ?",Y6
1180  Y=G2+Y3+Y4+Y5+Y6
1190  #"Line 7  Total=";TAB(50);Y
1200  G3=.03*(A-W)
1210  #"Line 8  (3% of line 31 FORM 1040)=";TAB(50);G3
1220  G5=Y-G3
1230  IF G5<0 THEN G5=0
1240  #"Line 9  (line 7 minus line 8)=";TAB(50);G5
1250  #"Line 10  Total medical and dental expenses=";TAB(50);Y1+G5
1260  J1=Y1+G5
1270  #
1280  GOTO 1500
1290  IF R4$="N" THEN 2470
1300  #"Medical and Dental expenses."
1310  #
1320  #"Line 1  1/2 (but no more than $150) of Ins. prem.=";TAB(50);Y1
1330  #"Line 2  Medicine and drugs.=";TAB(50);Y2
1340  #"Line 3  1% of line 31=";TAB(50);G1
1350  #"Line 4  (line 2 minus line 3)=";TAB(50);G2
1360  #"Line 5  Bal. of Ins. prem. not entered on line 1=";TAB(50);Y3
1370  #"Line 6  Other medical and dental expenses."
1380  #TAB(8);" ";"a-Doctors, Dentists, Nurses, etc.=";TAB(50);Y4
1390  #TAB(8);" ";"b-Hospitals=";TAB(50);Y5
1400  #TAB(8);" ";"c-Other=";TAB(50);Y6
1410  #"Line 7  Total=";TAB(50);Y
1420  #"Line 8  (3% of line 31)=";TAB(50);G3
1430  G5=Y-G3
1440  IF G5<0 THEN G5=0
1450  #"Line 9   (line 7 minus line 8)=";TAB(50);G5
1460  #"Line 10  Total medical and dental expenses=";TAB(50);Y1+G5
1470  INPUT "RETURN to continue, please.",R$
1480  #
1490  GOTO 1610
1500  #"Taxes"
1510  #
1520  INPUT "Line 11  State and local income taxes ?",B1
1530  INPUT "Line 12  Real estate taxes ?",B3
1540  REM
1550  INPUT "Line 13  State sales tax ?",B5
1560  INPUT "Line 14  Personal property ?",B7
1570  INPUT "Line 15  Other ?",B6
1580  B=B1+B3+B4+B5+B6+B7
```

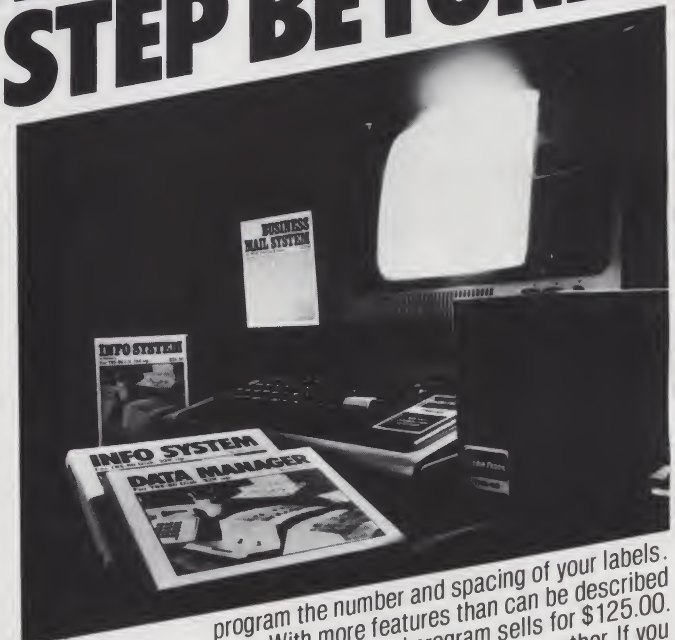

✓ Reader Service—see page 227

```
1590 GOTO 1720
1600 #
1610 #"Taxes."
1620 #
1630 #"Line 11  State and local income taxes=";TAB(50);B1+B2
1640 #"Line 12  Real estate taxes=";TAB(50);B3
1650 REM
1660 #"Line 13  General sales tax=";TAB(50);B5
1670 #"Line 14  Personal property tax=";TAB(50);B7
1680 #"Line 15  Other=";TAB(50);B6
1690 #
1700 #"Line 16  Total taxes=";TAB(50);B
1710 GOTO 1820
1720 #
1730 #"Interest expense."
1740 #
1750 #"Do you have any ?" : INPUT R6$
1760 IF R6$="Y" THEN 1770 ELSE 1840
1770 INPUT "Line 17  Home mortgage ?",C1
1780 INPUT "Line 18  Credit and charge cards ?",C2
1790 INPUT "Line 19  Other ?",C3
1800 C5=C1+C2+C3
1810 GOTO 1840
1820 #"Line 20  Total interest expense=";TAB(50);C5
1830 GOTO 1930
1840 #
1850 #"Contributions."
1860 #
1870 #"Do you have any ?" : INPUT R7$
1880 IF R7$="Y" THEN 1890 ELSE 1950
1890 INPUT "Line 21  Cash Contributions."j-D1
1900 INPUT "Line 22  Other than cash ?",D2
1910 D=D1+D2
1920 GOTO 1950
1930 #"Line 24  Total contributions=";TAB(50);D
1940 GOTO 2070
1950 #
1960 #"Casualty or theft losses."
1970 #
1980 #"Do you have any ?" : INPUT R8$
1990 IF R8$="Y" THEN 2000 ELSE 2090
2000 INPUT "Line 25  Loss before insurance reimbursment ?",E1
2010 INPUT "Line 26  Insurance reimbursment ?",E2
2020 E4=E1-E2 : IF E4<0 THEN E4=0
2030 #"Line 27=";TAB(50);E4
2040 INPUT "Line 28  Enter $100 or line 27, whichever is less ?",E5
2050 E=E4-E5
2060 GOTO 2090
2070 #"Line 29  Total casualty or theft losses=";TAB(50);E
2080 GOTO 2190
2090 #
2100 #"Misc.deductions."
2110 #
2120 #"Do you have any ?" : INPUT R9$
2130 IF R9$="Y" THEN 2140 ELSE 2180
2140 INPUT "Line 30  Union dues ?",F1
2150 INPUT "Line 31  Other ?",F2
2160 #
2170 F=F1+F2
2180 GOTO 480
2190 #"Line 32  Total Misc. deductions=";TAB(50);F
2200 #
2210 IF M2$="Y" THEN 2230
2220 INPUT "Line 40 Schedule A .... Deductions excluded? ",F3
2230 INPUT "RETURN to continue, please. ",R$
2240 #
2250 #TAB(15);"SUMMARY OF ITEMIZED DEDUCTIONS."
2260 #
2270 #"Line 33  Total medical and dental=";TAB(50);J1
2280 #"Line 34  Total taxes=";TAB(50);B
2290 #"Line 35  Total interest=";TAB(50);C5
2300 #"Line 36  Total contributions=";TAB(50);D
2310 #"Line 37  Total casualty or theft=";TAB(50);E
2320 #"Line 38  Total miscellaneous=";TAB(50);F
2330 #
2340 G=B+C5+D+E+F+J1
2350 #"Line 39  Total deductions=";TAB(50);G
2360 #"Line 40  Amount of deductions excluded =";TAB(50);F3
2370 #"Line 41  (line 39 minus line 40)=";TAB(50);G-F3
2380 I=G-F3
2390 IF I<0 THEN I=0
2400 W6=A-W
2410 #"Income less deductions (";W6;"-";I;")";TAB(50);W6-I
2420 #"Taxable Income=";TAB(50);W6-I
2430 IF M2$="Y" THEN 2480
2440 #
2450 #"Enter tax from table" : INPUT T1
2460 INPUT "Amount withheld= ?",T
2470 #"Taxable income=";TAB(50);W6-I
2480 #"Tax from table=";TAB(50);T1
2490 #"Taxes withheld=";TAB(50);T
2500 #
2510 #"Amount of tax still due=";TAB(50);T1-T
2520 #
2530 CLOSE (PRINTER,X)
2540 INPUT "Do you wish to reveiw ?",M2$
2550 IF M2$="Y" THEN 480 ELSE 2560
2560 #" " : #" "
2570 #"End of program---Micro hopes it has been useful to the human."
2580 #"Please come again."
2590 GOTO 3360
2600 #
2610 #
2620 #TAB(14);"SCHEDULE D -- Capital Gains and Losses"
2630 #
2640 #"Part I--Short-term Capital Gains and Losses.(1 year or less)"
2650 #
2660 #"Do you have any ?" : INPUT R$
2670 IF R$="Y" THEN 2680 ELSE 2730
```

```
2680 #"Part I Short-term Capital Gains and Losses."
2690 INPUT "Line 1  Sales price ?",L1 : INPUT "Cost ?",L2
2700 INPUT "Line 1  Sales price ?",L3 : INPUT "Cost ?",L4
2710 L6=(L1-L2)+(L3-L4)
2720 #"Line 8  Net short-term gain or loss=";TAB(50);L6
2730 #
2740 #"Part II--Long-term Capital Gains and losses.(1 year or more)"
2750 #
2760 #"Do you have any ?" : INPUT M3$
2770 IF M3$="Y" THEN 2780 ELSE 2860
2780 INPUT "Line 9  Sales price ?",U1 : INPUT "Cost ?",U2
2790 INPUT "Line 9  Sales price ?",U3 : INPUT "Cost ?",U4
2800 INPUT "Line 9  Sales price ?",U5 : INPUT "Cost ?",U6
2810 U8=(U1-U2)+(U3-U4)+(U5-U6)
2820 #"Line 20  Net long-term gain or loss=";TAB(50);U8
2830 #
2840 #
2850 #"Part III Summary of Parts I and II"
2860 #"Line 21= Combine lines 8 and 20. ";TAB(50);L6+U8
2870 P1=L6+U8 : P2=.5*P1 : P3=L6+.5*U3
2880 REM LINE 21 SHOWS A GAIN
2890 K1=.6*U8 : K2=.6*(P1)
2900 IF P1<0 THEN 2960
2910 IF K1<K2 THEN K3=K1 ELSE K3=K2
2920 #"Line 22a =";TAB(50);K3
2930 #"Line 22b =";TAB(50);P1-K3
2940 IF P1>0 THEN 400
2950 K4=P1-K3
2960 REM LINE 21 SHOWS A LOSS
2970 #"Line 23-If line 21 shows a loss-"
2980 #TAB(4);"a. Enter one of the following amounts:"
2990 IF L6=>0 THEN #TAB(6);"(i)   50% of line 21=";TAB(50);P2
3000 IF U3=>0 THEN #TAB(6);"(ii)  line 21=";TAB(50);P1
3010 IF L6<0 AND U8<0 THEN #TAB(6);"(iii) Line 8 + 50 %line 20";TAB(50);P3
3020 #
3030 #TAB(4);"b. Enter on FORM 1040 line 14, the smallest of:"
3040 #TAB(6);"(i)   The amount on line 23a."
3050 #TAB(6);"(ii)  $3000 ($1500 if married and filing a separately)"
3060 #TAB(6);"(iii) Taxable income as adjusted."
3070 #
3080 GOTO 400
3090 REM
3100 #TAB(15);"SCHEDULE B -- Interest and Dividend Income"
3110 #
3120 #"Part I Interest income."
3130 #
3140 INPUT "Interest income ?",I1
3150 INPUT "Interest income ?",I2
3160 A3=I1+I2
3170 #
3180 #"LINE 2  Total.(Enter on FORM 1040 line 9)";TAB(50);%$C?10F2;A3
3190 #
3200 GOTO 200
3210 #
3220 #TAB(25);"SCHEDULE B"
3230 #"Part II Dividend income."
3240 #
3250 INPUT "Dividend ?",V6
3260 INPUT "Dividend ?",V7
3270 INPUT "Dividend ?",V8
3280 V0=V6+V7+V8
3290 #
3300 #"Line 4=";TAB(50);%$C?10F2;V0
3310 INPUT "Line 6  Nontaxable distributions ?  ",V9
3320 #"Line 8 (Subtract line 6 from line 4)=";TAB(50);V0-V9
3330 #"Enter line 8 on FORM 1040 line 10a."
3340 #
3350 GOTO 280
3360 END
```


✓ *Reader Service—see page 227*

TBS-80 DATA PROCESSING SYSTEMS. ONE STEP BEYOND.



If you thought the TRS-80™ microcomputer was just a toy, think again. These **TBS-80** software systems will turn that computer into a **powerful data processor.**

INFORMATION SYSTEM by Dale Kubler is simply the best in-memory, data base manager on the market. It allows you to create files with up to ten fields per record, up to 40 characters per field and 200 characters total per record. Data from the keyboard is entered directly onto a screen display of one entire file. Once entered, you can sort or search your entire data base by any category and have the information desired displayed on the screen. **INFORMATION SYSTEM** provides a thorough editing mode allowing changes by line without rewriting an entire file. This program allows you to program your own printouts to almost any form you desire for line or serial printers. Screen prints from anywhere in the program are also available **INFORMATION SYSTEM** creates either disk or cassette files depending upon the version you use. From mail lists to recipes, this program is the ideal small system information manager. The price for this program, 32K up disk is $34.50. For systems 16K up tape it's $24.50.

DATA MANAGER by Dale Kubler starts out where INFORMATION SYSTEM leaves off. Requiring 32K and one disk, it accepts up to ten user-defined fields with up to forty characters per field and 255 characters per record. As with all TBS software, data entry and editing is professional and simple to use. What makes this program stand apart from "in-mem" data managers is that it uses up to four disks on line as memory, or as much as 320K of memory storage. Because disk sorts take more time than in-mem sorts, **DATA MANAGER** enables the user to create and maintain up to 5 "key" sort files for quick access of data. A utility program is provided to calculate the number of records possible since the amount of records you can maintain is dependent on a number of variables. This program also supports the upper/lower case modification, and printouts can be programmed to almost any format and sent to line or serial printer. Background printing is provided enabling the computer to search and print at the same time. If you already have INFORMATION SYSTEM, **DATA MANAGER** will accept those files. A necessity for organized people, this program sells for $49.50.

BUSINESS MAIL SYSTEM by Dale Kubler is designed for large-scale business users. Requiring 32K, two disks and printer, this program will store up to 150,000 names in a single file spread out over multiple disks. Each data disk holds 500 names. After data entry, BMS automatically sorts the data by zip code and alphabetical order within the zip code. The program tells you when and which data disk to insert, expanding your files automatically until you've reached 300 disks. Data is input directly onto formatted screen display with the option to use Company Name/Attention instead of Last Name/First Name. Three numeric and one alpha code fields are provided to help you use the search and printout mode. **BUSINESS MAIL SYSTEM** allows you to program the number and spacing of your labels. With more features than can be described here, this high-powered program sells for $125.00.

TEXT MERGE is the program that puts it all together. If you have the ELECTRIC PENCIL from Michael Shrayer, 32K and one disk drive, then this program is a must. It will merge your data base from any of the above programs with an Electric Pencil file. For example, when you write a letter that is going to several hundred people, you can "code" it by entering a field name from the above programs in place of the actual information. Then, when **TEXT MERGE** is run, it will print out your Pencil file and substitute the "code" with the actual data. In other words, you can print out 1,000 personalized letters without stopping the computer. This program will also enable you to selectively search out only the records from your data base that you wish to use. Also included is the ability to set left, right, top and bottom margins, set page numbers anywhere on the page, and print out right justified if you so choose. **TEXT MERGE** will turn your computer into a powerful data processor and it sells on disk for $49.50.

TBS has other incredible software for Tandy's microcomputer. Intent on making it a powerful tool, we have **large scale business accounting systems, general accounting systems, system utilities** and the **Library 100.** We have the only **DISK HEAD CLEANER** (for APPLE too!) and **GRAN MASTER DISKETTES,** the best on the market.

TBS is **YOUR COMPANY,** and we build systems, not just software. The above products are available now, nationwide. Visit your local Computer Dealer or Associate Radio Shack Store and demand the best, demand TBS. For more information, contact us through the numbers below.

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✓ Reader Service—see page 227

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Author's note: The Dallas system listed last month has closed down.

Dial-up Directory

Have you been hooked on the "dialing-up" habit yet?

Dialing-up can become addictive! The number of users on the Computer Bulletin Board Systems (CBBS) is growing daily. This article reviews and comments on a modem system—it is much more than just a modem—that will really hook you.

Micromodem II

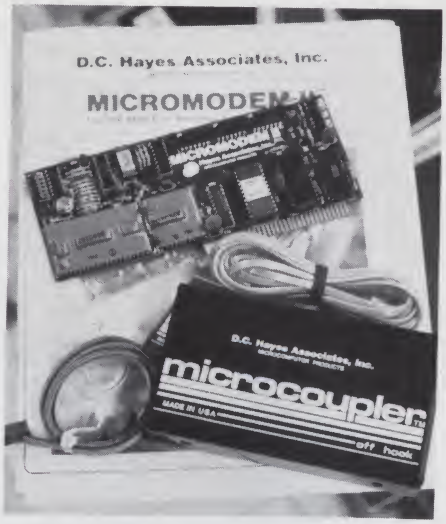
This modem board from D. C. Hayes (PO Box 9884, Atlanta GA 30319) plugs into your computer and does nearly everything. I have hesitated to buy one, however, because I thought there might be some fancy programming involved in interfacing into my S-100 system.

D. C. Hayes has taken the worry out of this interface for Apple II users. The Micromodem II includes a board, which plugs right into the Apple II, all of the cables and a direct access arrangement (DAA), which keeps unwanted tones off the phone company's lines. A 1K ROM mounted on the modem board is set with just the right program to turn the Apple into an automatic communications device.

The manual that comes with the D. C. Hayes Apple II modem includes easy-to-understand instructions written in a pleasant style and well illustrated. I am sure my nine-year-old could install the modem board and operate the system with no problem using the manual. Several excellent sections of background material describe the modem actions, telephone systems and digital communications systems.

I do have one complaint, however. The manual discusses local keyboard control and remote terminal control of the computer. It never relates this to the originate or answer mode of modem operation. These are basic and essential terms that a user might need in talking to people with other equipment. Otherwise, the manual really sets the standard for others to shoot for.

The D. C. Hayes Apple II modem system provides for three modes of operation: it will turn the Apple II into a dumb terminal for work with a host computer system or for data calls; it will allow it to operate as a host (remote console,control); it will allow it to operate under the control of a BASIC program. It has automatic answer and automatic dialing. The baud rates (300 or 110), out-dial and hang-up are all under software control. It is possible to save a BASIC program entered by a remote terminal while your Apple II is operating as a host, but more extensive saving of text or data must be done under BASIC programs.



The Micromodem II package is complete and ready to plug into your computer and phone jack. The board contains high-quality audio filters, tone generators and receivers, and 1K of ROM firmware that ties everything together.

The Dow Jones Stock Market Reporter package will run with the D. C. Hayes modem with only slight modification. I have seen advertised software that makes the Apple II and D. C. Hayes combination into a CBBS. Check the San Diego Apple systems (714-582-9557 and 714-449-5689) or the Original Apple Corps (213-340-0135) for more information.

An acoustical modem would probably be less expensive, but it would not provide nearly the same integrated capability.

Smart Software

As I use the term, a smart terminal is one that will both transmit prestored data and save transmitted and received data on some medium for future recall. A nice feature would be the ability to later manipulate or edit the data you have received. This ability is usually provided by software running on a microcomputer.

The Telestar program gives you this capability. This 8080 assembly-language program is available from Leonard E. Garcia (3517 Herschel Ave., Dallas TX 75219) for only about $30. It is set for North Star disk systems, but you Micropolis users should know how to run North Star disks by now. It needs a minimum of 8K of RAM starting at 2A00.

Telestar has three modes: file transfer, write or read. File transfer provides two Telestar users with the ca-

The following list provides the location, phone number and other information about systems around the country. Unless otherwise shown, all systems operate 24 hours a day. Hit at least three carriage returns to set the speed. I have personally checked into all of these systems. That is my only guarantee. These were verified from my list of over 110 "reported" systems.

LOCATION	PHONE NO.	COMMENTS
Arizona		
Phoenix	602-957-4428	Mail function for frequent users. Msgs by categories.
California		
Buena Park	714-739-0711	Nonbusiness hours only.
Hawthorne	213-675-8803	May not be 24 hr. ABBS
Hughes Acft.	213-679-0591	Mainly Hughes employees.
Huntington Beach	714-962-7979	Not 24 hr. Not heavily used.
Irvine	714-751-1422	ABBS
Los Angeles	213-349-5728	Nonbusiness hours.
Marina Del Ray	213-821-7369	ABBS
Orange County	714-526-3687	COMM 80. Different software.
San Jose	408-263-0248	Billboard 80. Different too.
District of Columbia		
Washington	202-337-4694	Forum 80. Selective msg sort.
Florida		
West Palm Beach	305-689-3234	ABBS (erroneously listed in CA last month).
Illinois		
Naperville	312-420-7995	Nonbusiness hours. ABBS
Kansas		
Wichita	316-746-2078	Forum 80.
Massachusetts		
Dunstable	617-649-7097	Forum 80. Program transfers.
Missouri		
Springfield	417-862-7852	ABBS
New Jersey		
Pompton Plains	201-835-7228	Nonbusiness hours only. ABBS
New York		
Staten Island	212-448-6576	ABBS
Texas		
San Antonio	512-657-0779	ABBS
Washington		
Seattle	206-524-0203	ABBS

Special Listing

Potomac Micro Magic has a special modem test service open on an "as available" basis. They will echo and send a test message at various baud rates. This will allow you to test without tying up other systems. Dial them in Virginia at 703-750-0930.

pability of exchanging actual program and data files. The write mode puts all of the transmitted and received data into RAM. When RAM is full or your call is done, the data is transferred to disk. Read allows you to locally read or print out files.

The write mode is convenient for CBBS use. You can ask the CBBS for a quick summary of messages, get the ones you want and store them without running up costly phone bills. You can later recall the messages and make notes about phone numbers, equipment for sale, etc., at your leisure. You can list programs from a host computer. But because Telestar puts everything on disk file in ASCII, the tokens will be wrong to actually run the program. Only the transfer mode can save a program that will run, but you must have a Telestar at each end to do it.

Telestar has a unique self-adaptive feature. You can enter the program and use its own internal prompts to tailor your own port, memory and character bits. The program will then save itself in its new tailored form.

Telestar users who have Electric Pencil can enter the ASCII files, edit out all of the unwanted data and save the important information from a data call session in a concise form.

Telestar is a real bargain that can make North Star and other similar disk-based systems into sophisticated smart terminals. Be sure to mention if you have a Telestar capability when you send your listing to the Dial-up Directory.

CBBS Spotlight

There is a new system in the spotlight this time. The CBBS Northwest in Beaverton OR (503-646-5510) is run by Jim Willing and Bill Marx. It became operational on May 8, 1979. They are using a single disk with a Potomac Micro-Magic modem card. The system and software follow the pattern of the CBBS in Chicago developed by Ward Christensen and Randy Suess.

The friendly "natives" on this system have discussed several interesting topics, such as movie reviews and a need for old pinsetting machine parts. The summary (S) command on this system includes information about the length of each message. A message may be up to 16 60-character lines, so it is helpful to know the size of the message you are calling out. The routine that allows you to enter (E) a message also lets you edit it line by line, but then you must remember to save it on disk or else it will not be retained.

Bill and Jim also maintain a voice-answering machine so users can report system problems verbally. CBBS Northwest is a pleasant meeting place for people of diverse interests. It is a welcome addition to the CBBS roster.

Listings

We want to list the name, number, available times, equipment capabilities and interests of anyone who would like to exchange data calls. We would also like to keep a current list of the Computer Bulletin Board Systems operational and any special features they provide. If you run a CBBS, what are your plans? How about TELENET linking? What are your problems? Drop me a line at PO Box 17283, Montgomery AL 36117. Please include an SASE. ■

Gregory Yob
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Palo Alto CA 94301

The Comprint Printer

Tired thumbs prompted this author to buy the Comprint printer, which he reviews here.

About 18 months ago, I was asked to write some code to test the interface between a PET and a new printer under development. I liked what I saw, especially the simplicity of the printer's mechanism and the speed (over 200 cps).

I eventually became tired of thumbing my way through the orders pile for a book I am writing and decided there had to be a better way. Perhaps it was time to spend some money for disks and a printer for my old Imsai, which had sat on the shelf gathering dust for the last two years, and thus let my computer do the thumbing for me. At least I could call this a business expense and get a new toy if it didn't work out well.

Several years ago, I spent much time working with a TI Silent 700, and before that, a Teletype. It was clear that a printer that dozed along at 30 or 60 characters/second would leave me fidgeting in my chair waiting for my printouts.

I called the printer company and learned that the Comprint could be provided in two forms: a serial interface with a Teletype current loop or a parallel interface that could work in 8-bit parallel handshake or be a listener on the IEEE 488 bus. Since my other computer is a PET, one printer could be used for both machines. So I decided to purchase the Comprint printer.

What Makes This One So Special?

The Comprint is a non-impact printer that uses a special electrosensitive paper coated with black dye and a thin layer of aluminum deposited on top. When a column of styli (similar to the styli in a dot-matrix printer) is swept across the page, an electrical pulse vaporizes the aluminum and reveals the black dye. Suitable timing of the electrical pulses will produce letters on the paper.

Since this process has no moving parts other than the motion of the printhead and the paper, the printing rate can be quite rapid. The speed is at least ten times that of a thermal printer, and there are no ribbons or stylus solenoids to consider, which makes the mechanism simple and lightweight.

The Comprint mechanism is further simplified by the elimination of the stop/start paper feed mechanism that most printers use. As the stylus head moves across the page, the paper is fed upward at the same time. To make a level line of print, the carriage is tilted upward. Fig. 1 shows this method schematically, and Photo 1 shows the Comprint's mechanism.

The Comprint's stylus is 12 dots high and staggered so the dots overlap in the letters. Fig. 2 shows a sample of the Comprint's output, and you will notice that the lowercase letters have real descenders, which make the print easy to read. (The character matrix is 9 × 12.)

The printer buffers up to 256 characters and prints one line at a time (80 characters). Since there is no direct carriage return, spaces are added to the end of short lines. The total rate is 170 lines per minute, or about 225 characters per second for full lines. This is nearly three full pages per minute, or about half the speed of a commercial 300 lpm printer (that costs five times as much).

Interfacing to the Comprint is by two basic options: serial or parallel. The serial option costs a little more than the parallel one. My experience is with the parallel model, since both of my computers have parallel interfaces.

The serial option provides an RS-232C standard serial interface and a 20 mA current loop for Teletype-like devices. A set of jumpers on the serial I/O board is used to select the mode of operation and the details of the I/O. These include:

110, 150, 300, 600, 1200, 2400 and 4800 baud data rate.
Received or transmitted data to be printed.
Data Set Ready or Clear To Send as the busy signal.
Seven or eight data bits.
One or two stop bits.

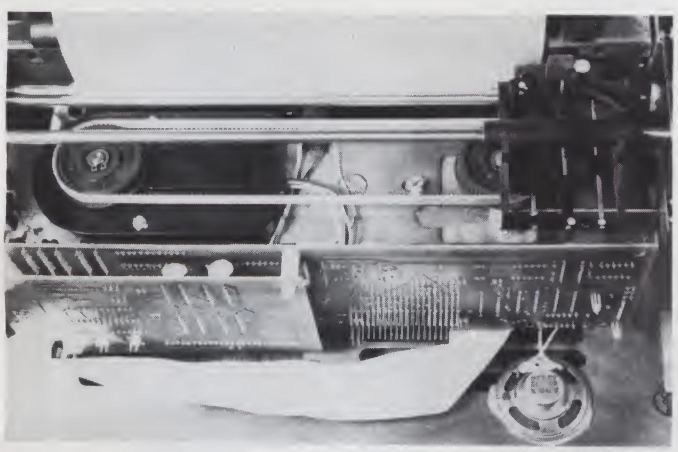

Photo 1. With the cover off, the simplicity of the Comprint mechanism is revealed. The oval belt slides the stylus head past the paper, which is friction-fed continuously during printing. When the printer is idle, the printhead is to the right.

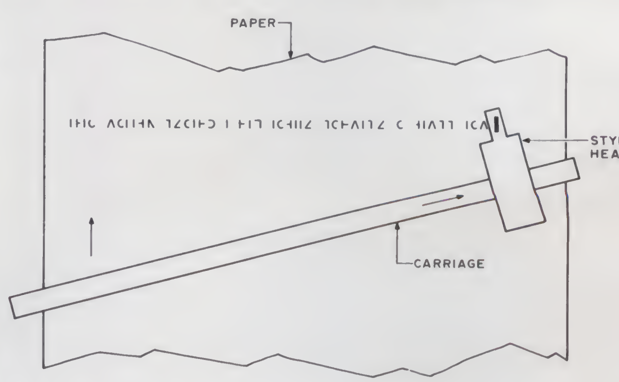

Fig. 1. The stylus head is mounted on a tilted carriage. As the paper advances, the stylus head moves up at the same rate, resulting in a level line of print. This eliminates the start/stop mechanism found in most printers.

RS-232 or 20 mA loop as data source.

Choice of polarity and current/no current for mark/space in the 20 mA current loop.

The current loop is optically isolated by passing the current through an LED and a resistor incorporated in an optocoupler.

The parallel option provides for either the IEEE 488 bus protocol or a parallel data with Strobe/Acknowledge handshaking. I used the IEEE 488 option for connection to my PET. The parallel options are:

IEEE 488 device addresses of 3, 4, 6 or 28.

Print *all* characters, including those with ATN set low, as an aid for debugging.

"Narrow" Strobe/Acknowledge parallel—a narrow active low strobe is used.

"Wide" Strobe/Acknowledge parallel—timing is less critical.

Some of the IEEE lines are used for Strobe/Acknowledge, which requires the Comprint to use an "active low" voltage protocol. Those with "active high" interfaces should take note.

My printer arrived with two application notes that told how to interface the Comprint to the Apple II Parallel Printer Interface Card and to the TRS-80 PC board 1184 Rev C for the TRS-80 Expansion Interface. For the PET, the Comprint interfaces directly to the IEEE 488 bus. Comprint also offers a Centronics-Compatible interface.

If you have a CRT terminal and wish to dump the entire screen on the printer—and while the printer is printing, to do something else on your CRT—there is an expansion buffer memory card that provides a 2048 (2K) byte buffer for the Comprint. With this option, you can send up to 2K characters to the Comprint before the printer tells your computer that it can't accept any more characters.

Packing, Documentation and Setup

The printer arrived in a double box—an outer box that held an inner box with foam-rubber corner holders. The inner box contained the printer and the instructions. The unpacking instructions stated loudly and clearly that a specific order of unpacking was required. As I unpacked, it became apparent why this was so. The instruction manual (64 pages) was very clear and included drawings and photos as needed.

I had to supply my own connector for the end of the Comprint's I/O cable, and initially I selected an edge connector that fit my PET. The tables in the instruction manual were clear, except that I couldn't find the ground wires! I called the Comprint Company, which informed me that the errata sheet indicated where the grounds were.

After wiring the cable, I set the jumpers on the I/O board for IEEE 488, using device address #4. Though the instructions insisted that you should remove the I/O board, I noticed that a pair of needle-nose pliers were sufficient to pull and replace the jumper pins. (Removal of the I/O board is quite tricky, as it is connected to the main board with 20 wire-wrap pins. I am glad I took a look at this before trying it!) Anyway, I set the jumpers as indicated, and never had to remove the I/O board.

I hooked the printer to my PET, turned everything on and initialized the printer. When the Comprint is turned on, you must set it to "test" for a few lines for initialization. Then I opened an IEEE file in the PET and entered PRINT#4, "HELLO THERE". It all worked!

Performance and Control

The Comprint has an F-8 microprocessor with an on-chip

Photo 2. The author's home base.

ROM that does all the functions for the printer. This gives the printer a moderate amount of intelligence.

On the top of the printer are two switches. The upper switch has three positions—On Line, Off Line and No Print. The On Line position accepts characters and prints them. Off Line dumps the contents of the buffer, and the printer refuses to accept more characters. By switching to Off Line and back to On Line, you can test the printer, etc., without losing any transmitted characters. No Print accepts characters and does not print them. (In programming terms, this setting is a "bit bucket" into which the data vanishes.)

The other switch is also a three-position switch with two marks, Test and Paper Advance. Test prints a line of characters, shown in Fig. 3. Paper Advance does line feeds.

When the Comprint is turned on, you have to set it to Off Line and do a few Test lines. If you try Paper Advance first, the printer will not stop doing line feeds (until you set the switch to Test). It took me a few tries to learn about this one!

Several of the ASCII control characters are used to provide some control of the printer via the computer. Carriage returns pad the rest of a line with blanks, and line feed will provide 80 blanks to simulate a line feed. Bell will beep a speaker for about .3 second.

If you want some data to be ignored, you can use a Stop Print and Start Print character (US and GS). The Comprint will ignore all characters after a Stop Print . . . until a Start Print is received.

Two printing modes are allowed. The Paginate mode will print seven line feeds after every 58 lines, or will print enough line feeds to finish the page if a form feed is received. The Continuous Print mode does not paginate and ignores form feeds. When the printer is turned on, it is in Paginate mode.

Reliablility and Such Matters

After using the printer for a while, I noticed that the asterisk seemed to have a dot or two out of place. When I mentioned this to the Comprint people, they verified an error was present in the F-8's ROM. Since F-8s are ordered in quantities of 1000 or more, it will be a while before perfect asterisks will appear. However, the goof on the asterisk is very small, and I was told

About 18 months ago, I was asked to write some code to test the interface between a PET and a new printer under development. I liked what I saw, especially the simplicity of the printer's mechanism, and the speed (over 200 characters/second).

Fig. 2. Sample Comprint output (full size).

```
0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]↑_`abcdefghijklmnopqrstuvwxyz{:}~0
0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]↑_`abcdefghijklmnopqrstuvwxyz{:}~0
0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]↑_`abcdefghijklmnopqrstuvwxyz{:}~0
0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]↑_`abcdefghijklmnopqrstuvwxyz{:}~0
0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]↑_`abcdefghijklmnopqrstuvwxyz{:}~0
0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]↑_`abcdefghijklmnopqrstuvwxyz{:}~0

 !"#$%&'()*+,-./0123456789:;<=>?
@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]↑_
`abcdefghijklmnopqrstuvwxyz{:}~
```

Fig. 3. Comprint test pattern and character set. The upper pattern is generated when the printer is set to the Test mode. The lower pattern shows the entire 96-character set of the Comprint. (The lower pattern shows type at full size.)

that I was the first customer to notice it.

My first project with the Comprint was to write a program to make listings from my PET that indicated what was really in the PET's program. A LIST only provided some of my program listing, as all the special PET characters were ignored or appeared in uppercase when a graphics character was listed. (If you own a PET and are interested in this program, which works for all ASCII printers with lowercase, drop me a note.)

When I had my program working, I used it for a long program and discovered that the Comprint "hung up" in the middle of the program run. I took the printer back to Comprint, where they replaced the main board. My printer now works just fine! (There was some concern at Comprint whether my bug meant that there was a design flaw. The engineers were quite relieved that the replacement board cured the problem. So was I!)

Some inquires on lifetime and failure rate yielded the following:

1. The Comprint is good for about 50 million characters, or 5 years' "average" use. This works out to 30 rolls of 300 foot paper.

2. The main failure was the destruction of the stylus. Though there are many warnings to be careful when the the printer is operating with the top off, most of the returned units had damaged styli. When the cover is off, the paper tends to bend towards the front and catch in the printer stylus head. My solution was to mark my warning tag in red and to tape it to the top of the case as a permanent reminder.

Good Points

I like the Comprint . . . at least I have no intention of returning it. I intend to use it for program listings, some letters and masters for mailing lists. (The aluminized paper copies very nicely.) Its good features are:

1. Speed—225 characters/second is hard to beat.

2. No ribbons!

3. Lack of noise. When it's on standby, it's really quiet, and the printing noise is just the sound of the carriage moving.

4. Lightweight—15 pounds. When it's running, only 55 Watts of power are used, so it doesn't get warm.

5. The lowercase has descenders, and the 9 × 12 matrix makes readable characters.

6. Price—$660 is quite reasonable. (The serial I/O option is priced at $690. The 2K buffer is about $200 more.)

Annoyances

Most of these annoyances were cured one way or another. My main objection is that many small points were ignored to reduce the costs or to simplify things for the engineers, at the cost of standards. For example, the printer prints 11 characters per inch—elite type is 12 per inch, and pica is 10! The 80 character line is 7 ¼ inches long, which leaves almost no margins (¾ inch on the left, and ½ inch on the right). The vertical value is 5.83 lines/inch instead of 6. (I am anticipating some problems with mailing labels because of this.) Disadvantages of this printer are:

1. There is no cover provided for the paper holder, though slots for the cover are included in the case. I made one out of cardboard covered with vinyl shelf-paper. To hold the cover in place, I used some duct tape on the inside in the rear. Fig. 4 shows the pattern for the cover.

2. Without the cover, the paper tends to curl under the roll, and sometimes it will even feed through back to the printer.

3. The cable that came with the Comprint left about 20 inches free. I eventually had to make a separate cable and two more connectors to place the printer about 3 feet from my PET.

4. To change from parallel to IEEE 488 operation requires changing two jumpers. This means removal of the case. Since my Imsai uses the parallel strobe mode, I installed a DPDT switch on the case to rapidly switch between the Comprint's two modes.

5. Once a connector is placed on the cable, it isn't possible to disconnect or remove the cable. The cable is connected to the I/O board with a connector that is soldered in place. The cable feeds through a ventilation slot that is too narrow for a connector.

6. I miss (but not too much) the ability to do a true carriage return.

Availability

Comprint does not sell the printers on a retail basis. However, most computer stores should be able to order the Comprint through their distributors.

Summary

All in all, I like the little beast! It will serve my needs quite adequately. If you need to do a lot of printing, get another brand, as the Comprint is rather lightly built.

Comprint is planning to produce a graphics version with programmable characters. The present model cannot place the characters on the line accurately enough for good graphics, but it does zip right along! ■

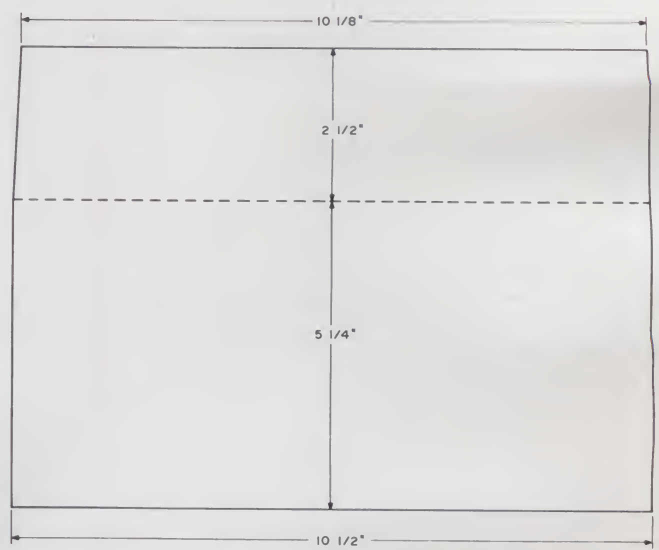

Fig. 4. Pattern for the rear cover of Comprint. Make the cover from heavy non-corrugated cardboard. Score with a sharp knife at the fold. After folding, put some vinyl shelf paper on the cardboard. Attach at the rear to the inside rear cover with adhesive tape. The cover prevents the paper from curling back into the printer mechanism.

Reader Service—see page 227

Programming the Z-80: Easy Does It!

A five-point advisory plan guides you through a complex task: Z-80 programming.

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A French comedy of the early 18th century by the Abbe D'Allainval carries the expressive title "An Embarrassment of Riches," with the subtitle "The more alternatives, the more difficult the choice." Anyone who has taken a close look at the instruction set of the Z-80 microprocessor will recognize this as the perfect description of the problem that plagues would-be Z-80 programmers. Faced with about 700 distinct machine codes, ranging in length from one to four bytes, with ten addressing modes, served by 22 registers and conditioned by six flags, you can easily get "lost in the fun house."

Most of us microcomputer programmer/users are not gung-ho machine-language types. Our bag is BASIC, PASCAL, APL and other high-level languages. For my part, I was ready to give up the whole thing. After all, who needs it? Well, I did, for one. I had an application written in BASIC that needed a little machine-language assist.

Sooner or later it happens: You have a handy, dandy, high-level language application that is just the thing except for one troublesome item: one part of the program executes much too slowly or uses too much storage. Perhaps it could use some machine feature not available to your application language. You need a little machine-language routine that can, for example, be called by your BASIC program, do its thing and then return control to the calling program.

At first glance, we appear to have three choices: we can limp along with what we have, hire an assembly-language programmer or invest a lot of time mastering machine language or assembly language or both. None of these choices are appealing, especially the last one. Why spend a lot of time and effort on a programming chore that comes up occasionally and then have to learn it all again the next time around, if there is a next time?

Assembly and machine languages are quite simple, though tedious. What, then, is the problem? The answer to this question resulted in an easy, yet practical (would you believe quick and dirty?), solution. It allows you to write simple Z-80 programs in a minimum amount of time without trying to master the language. These programs may not be the most elegant or efficient possible, but they work and are produced with an acceptable amount of effort. If you are in a similar situation, then this article is for you.

This article will not teach you assembly language. Rather, it offers an overall approach along with practical aids to allow you to immediately learn and use those parts of the language needed for your application. This collection of concepts and rules actually works, and we'll tie them up in a series of summary statements, or "advisories," as we go along.

Machine Language or Assembler

Before we get into details of the method, it may help to clear up a widespread confusion about the difference between machine language and assembly language. These two languages are different, yet they can look exactly alike. The expression ADD A,B means add the contents of register B to the contents of register A and store the result in A. Is ADD A,B a machine-language or an assembly-language expression? Most people would say assembly. In some sense, it is both. No wonder there is confusion.

The distinction is this: ADD A,B is a *mnemonic representation* of a machine-language instruction, but it is also an actual assembly-language *statement*. The Z-80 cannot read, accept or process it. On the other hand, the assembler will accept ADD A,B directly and convert it into a pattern of binary bits, 1000 0000. The latter is machine language

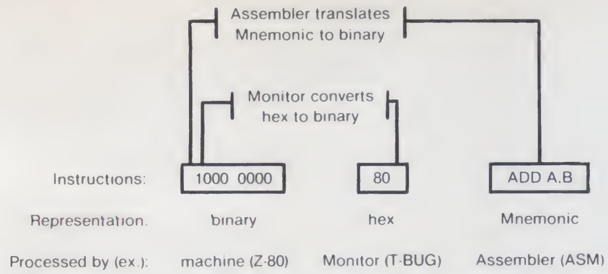


Fig. 1. Distinction between machine language and assembly language. A language instruction is a representation or name for an operation on data. In the case of the Z-80, as with most processors, there is a one-to-one correspondence between a binary machine instruction and its hex or mnemonic representation. Depending on the language selected, an instruction is processed, or understood, by a machine (binary), a monitor (hex) or an assembler (mnemonic). An assembler does much more than translate mnemonics to binary; it relieves the programmer of tedious error-prone address calculations and allows the use of variables, among other things.

and is acceptable to the processor for execution.

Mnemonics are much easier to grasp and remember than binary codes, but an assembler does much more than accept mnemonics. It permits the use of symbolic names or labels for addresses and data. The assembler calculates the actual addresses the machine requires and substitutes actual values where and when required. Except for very short programs, the use of labels and an assembler saves a great deal of work and minimizes errors.

Putting a Hex on the Byte

For very short programs, "hand-assembly" by entering a hexadecimal version of binary codes through the keyboard *may be* simpler and faster than using an assembler. It is quite common to represent machine instructions in hexadecimal (hex) form. Thus, 1000 0000 binary is conveniently expressed as the two-digit hex number 80. Strictly speaking, this is not machine language. You might call it monitor language, since most Z-80 monitors accept the direct entry of hex numbers and convert them to binary machine language.

Octal representation is sometimes used to represent binary machine codes, perhaps under the belief that it is easier to handle than hexadecimal. Octal has its virtues, and hex does look a little strange with its use of the letters A through F along with the familiar decimal digits. If you are new to this and intend to hand-assemble, then use hex.

For technical reasons we won't go into here, hex is more direct and is universally used by Z-80 texts, Z-80 manufacturers and most assemblers and disassemblers. If you insist on octal, you will find yourself doing double translation from one base to the other. Fortunately, with the aids put forward here, you won't need to get involved with number bases beyond using conversion tables. This brings us to our first advisory.

Advisory No. 1

Don't get hung up on hex, octal or mnemonics. They're just alternate names for an instruction. You can look them up in a table as needed once you have the key (see part 2). The important thing is to know where you're at. Do you plan to use machine language (hand assembly) or assembly language? Learn the difference. See Fig. 1.

Caveat Mnemonicor!

Before we get into the wonderful world of painless programming, let's go over some pluses and minuses, the good news and bad news, of the approach we'll be unfolding here. First the good news. Although this article does not teach Z-80 programming, it does offer a sound learning tool for self-study. This approach is far more effective than reading manuals and trying to absorb everything at once.

By actually writing and using simple programs from the start, you will learn the best way of all. When you tackle a specific task, you will be exemplifying the programming equivalent of "it is better to light a candle than to curse the darkness." Our emphasis, however, will be the need of the once-in-awhile machine-language programmer, the one who wants to get in and out fast without investing a lot of front-end effort.

The bad news is that there is no such thing as easy programming in any language, unless the problem and the program are simple. That's the escape hatch. There is a place for simple machine-language programs: somewhere inside your BASIC program where it handles a simple task, but fast!

The difficulty of programming rises exponentially with the generality, complexity and usually the size of an application. If you're out to tackle a machine-language "biggie," you had better master assembly language, or you'll be wasting your time and someone's money.

So the bad news is not really that bad as long as you don't let your first success with a simple Z-80 program go to your head. I am sure there is some law of human nature that entitles all programmers to have that marvelous "control the world! I can do anything!" feeling at least once in their lives—when they've run their first successful program. If you still have that feeling after program 1234, then you are either a genius or you have written 1234 simple programs.

Let's relate this to machine language and languages in general using the metaphor of a picket fence for three languages of differing levels.

APL: Build a picket fence around the property.

BASIC: Build a picket fence around the property, starting at the northeast corner. Go south for 50 fifty feet, etc.

Assembly: Locate the nearest survey marker, take a picket in your left hand, take a mallet in your right hand, drive the picket into the ground, measure four inches, take a picket, etc.

As long as the above represent meaningful collections of operations and objects, the languages differ only in the degree of their fragmentation, that is, in the amount of work a single statement performs. There are deeper, more subtle differences, but they can be ignored for our present purpose. Shifting from metaphor to simile, we can liken these languages to a giant power shovel, a mechanical ditch-digger and a hand shovel, respectively.

None of these differences relieve us from the usual requirements of good programming practice. We must still devise an algorithm, plan our data flow, specify correct branch and control logic.

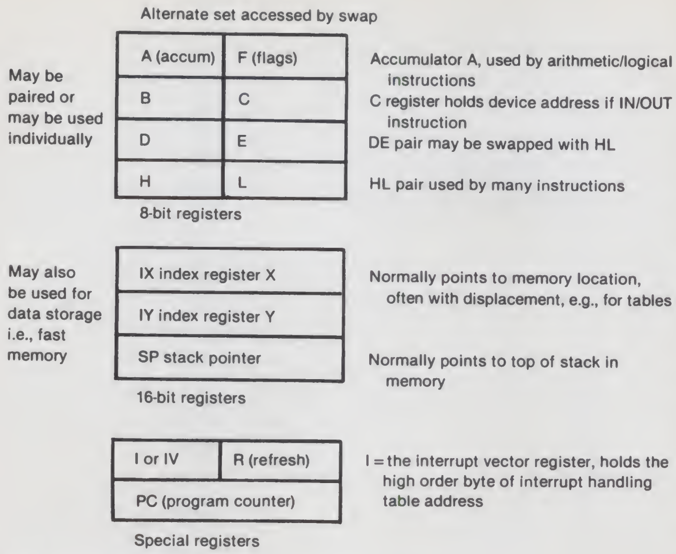
Advisory No. 2

If you're out to master assembly language by the method of this article, be prepared to write many short, simple programs before you tackle a heavy application. If, however, you want to augment a BASIC program with a simple machine-language assist, have a pad and pencil on hand for your second reading of this article. You'll be on your way to immediate solution of your problem.

Getting Ready

On your second, or program-writing, pass of this article, you will already have done several things. Just as important, you will also have *not done* certain things. For example, you must not read or try to understand the instruction set of the Z-80 processor. It is not only unnecessary, but it will also probably delay or even kill your chance of accomplishing anything with machine language.

This rule is easy to remember if you believe that anything more than a glance at machine-language code: a) is a step backward for a high-level language programmer, b) may cause irreversible brain damage or c) will turn you to stone. The first reason is enough for me. I don't really believe b and c, but why take chances.?



Flags (Set = 1, Reset = 0)

F-bit	Code	Name	Usual Action or Use
7	S	Sign	Set if result is negative
6	Z	Zero	Set if result is zero
4	H	Half-carry	Used for BCD arithmetic
3	P/V	Parity/Overflow	Set if overflow or parity even
1	N	Add/Subtract	Used for BCD arithmetic
0	C	Carry	Set if carry, or no borrow; reset after logical instruction

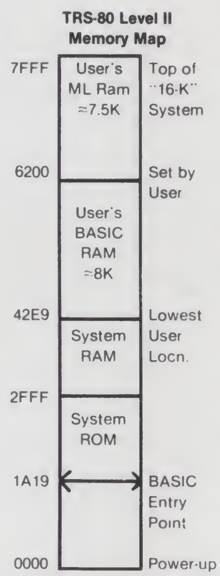


Fig. 2. Sample chart summarizing key features of programming interest. Your own chart should be tailored to your actual Z-80 system and be written in your own style. This example is for my TRS-80 system A reserved area for machine-language programs is shown starting at 6200 hex. Most extended BASIC interpreters provide for linkage with a protected user's machine-language program area. The notes suggest normal usage of registers and flags.

Advisory No. 3

Do not, repeat, do not try to read, study, understand or memorize the Z-80 instruction set. It is not necessary and is counterproductive.

Among the things you will have done are:

1. Outline the problem to be solved; for example, to move (copy) a block of data from here to there in memory. Perhaps it might be to read every nth value in a table in memory and send it to an output port, until a given test is satisfied. Use whatever methods you find useful in your high-level language programming—methods such as narratives, diagrams, tables, equations. You will also have decided whether you want to optimize storage space or running time or simply use special features.

2. You will have read enough about the Z-80 processor and assembly language to decide in a preliminary way how you will use the registers, memory and external devices.

"Aha!" you are thinking. "I knew it was too good to be true." But wait, you have been spared the necessity of grappling with hundreds of instructions, and besides, there is an easy, actually pleasurable, way of learning what you need.

Parallel Reading

This easy method of studying and absorbing new subjects is called parallel reading. It simply means you don't rely on just one book or article for information. Look for the same subject in two, three, perhaps a half dozen different sources. Try it! You will be amazed. Points that are overlooked or unclear in one source will be beautifully and simply explained in another and vice versa.

By thus hopping back and forth and not letting yourself get hung up on some point, you will become an "instant expert" with lots of related information and a good conceptual overview. I have used it successfully on such diverse subjects as microprogramming, game theory, quantum mechanics, damp basements, active filters, etc. It is practically guaranteed to work.

In the case of Z-80 programming, I have found Barden's *Z-80 Microcomputer Handbook* (Howard W. Sams & Co., Inc., Indianapolis IN, 1978) and Osborne's *Programming for Logic and Design* (Osborne & Associates, Berkeley CA, 1978) particularly useful. Also useful is the manual that comes with the TRS-80 Editor-Assembler (TRS-80 Editor/Assembler, *Operation and Reference Manual*, Cat. No. 26-2002, Radio Shack, Tandy Corp., Ft. Worth TX, 1978). Among its many tables is a cross-assembler table that allows you to convert a mnemonic to machine code or vice-versa. Such a table is indispensable if you plan to do hand assemblies.

Another great aid for hand assemblies is a program called a disassembler. It will read machine-language code and convert the instructions to mnemonic form. It's a great help in debugging your programs. Some monitors, such as that of Small Systems Software (PO Box 366, Newbury Park CA 91320) for the TRS-80 include a built-in disassembler.

Advisory No. 4

Get several references on Z-80 programming and study them in parallel for information on particular subjects. These include the names, size and function of registers; the meaning of operand forms such as HL versus (HL); where data and addresses come from and how they are stored; the use of labels and the meaning of the Z-80 flags. Addressing modes can be glossed over at this point. Don't try to plan the use of registers in detail. These points can be resolved more efficiently after your program has taken its initial form.

Advisory No. 4 may seem like a tall order, but it is not. Most of the material can be summarized by a few diagrams and notes on a single page. If you prepare such a summary, it will confirm your understanding and provide a convenient working reference. A simplified sample chart is shown in Fig. 2. It is strongly recommended that you adapt this chart to your own needs.

Advisory No. 5

Outline the specific programming problem that is to be implemented in machine language. Use your normal program design tools such as charts, diagrams, tables, narratives. Define the principal variables, sequence of operations, tests and limits peculiar to your problem. Don't worry about machine-language constraints at this point. Any operation not supported directly by the Z-80 can be broken down later into separate steps.

At this point, if you have done your homework (Advisory No. 4), you will be ready to write your machine-language program immediately after a once-through familiarization scan of part 2 of this article, which discusses the classification of instructions and provides an example of programming the Z-80 "the easy way."■

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172-030

Reader Service—see page 227

Multiple Page Graphics for the Apple II

You can use this program to "flip through the pages" in your Apple.

John Rowe
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Long Beach CA 90814

Chris Grossman
6791 Westminster
Westminster CA 92683

The Apple II can alternately display two pages of low-resolution graphics by direct POKE commands. When in the graphics mode, POKE – 16299,0 displays page 2 and POKE – 16300,0 displays page 1. It is possible to draw additional pages, store these in memory and then recall them sequentially to produce flashing or animated graphic effects.

One page of graphic display requires 1K of memory. Using a simple machine-language subroutine entered at $300, a page drawn in page 1 may be transferred to page 2 or to any location in memory. When needed, it is transferred back by the same subroutine. LOMEM must be set above the end of the last page stored.

Two POKE commands are entered prior to calling the subroutine—POKE 775,X, where X is the high-order byte (in decimal) of the address in memory of the donor page, and POKE 779,Y, where Y is the high-order byte of the address of the receiving page. POKE 775,4:POKE 779,8:CALL 768 transfers page 1 to page 2. Subsequent convenient locations in memory are pages starting at 12, 16, 20, 24, etc. (i.e., $0C, $10, $14, $18, etc.). POKE 775,12:POKE 779,4:CALL 768 transfers the page of graphics starting at $0C00 to page 1 for display.

If page 1 is displayed while the donor page is moved directly to the page 1 memory, there will be a brief overlapping of portions of the images, which may be distracting. The best technique is to display page 2 while writing to page 1, then to display page 1 while writing to page 2, and so on. This technique can "turn" pages as fast as every 25 msec. A delay loop must be inserted between page turns to slow the rate of display.

This demonstration program draws a checkerboard display and then produces a sequential reversal of the individual four quadrants of the checkerboard. The program draws eight pages of graphics and runs in a 16K system.

```
*300L

0300-   A9 00       LDA   #$00
0302-   85 02       STA   $02
0304-   85 04       STA   $04
0306-   A9 04       LDA   #$04
0308-   85 03       STA   $03
030A-   A9 08       LDA   #$08
030C-   85 05       STA   $05
030E-   A2 04       LDX   #$04
0310-   A0 00       LDY   #$00
0312-   B1 02       LDA   ($02),Y
0314-   91 04       STA   ($04),Y
0316-   C8          INY
0317-   D0 F9       BNE   $0312
0319-   E6 03       INC   $03
031B-   E6 05       INC   $05
031D-   CA          DEX
031E-   D0 F2       BNE   $0312
0320-   60          RTS
0321-   00          BRK
0322-   00          BRK
*
```

Machine language program.

Program Design

Machine-language program.
$300-$321—moves $400 bytes of memory in a block.

Integer BASIC program.
5—Set Lomem.
10–45—Enter variables.
100–180—Draw eight pages of graphics, each ¼ field different from the others.
300–345—Sequential display routine.
400–425—Exit display routine.
1000–1145—Subroutine to draw ¼ checkboard field with any combination of check height and width.

For those interested in exploring the possibilities of the technique, a Programma International program titled "3-D Animation" uses it to draw and animate complex graphics using 24 pages. Because of the memory and data-storage requirements, a 48K system with disk is needed for proper use. ■

BASIC program.

```
LIST
    5 POKE 74,0: POKE 75,44: POKE
      204,0: POKE 205,44: REM   SET LO
      MEM FOR 8 PAGES OF GRAPHICS
   10 CALL -936: PRINT "MULTIPLE PAGE
      GRAPHICS FOR THE APPLE II"
   15 TAB 18: PRINT "BY"
   20 TAB 10: PRINT "J ROWE & C GROSSM
      AN"
   25 VTAB 6: PRINT "PADDLE (0) CONTRO
      LS THE SPEED OF DISPLAY"
   30 VTAB 8: PRINT "WHEN THE DISPLAY
      IS RUNNING HIT ANY": PRINT
      "KEY TO STOP AND CHANGE THE PATT
      ERN"
   35 VTAB 12: INPUT "ENTER SQUARE WID
      TH (1-20,TRY 5)",W: IF W=0 OR
      W>20 THEN 35
   40 PRINT : INPUT "ENTER SQUARE HEIG
      HT (1-24,TRY 6)",H: IF H=0 OR
      H>24 THEN 40
   45 PRINT : INPUT "ENTER 2 COLORS (0
       TO 15)",C1,C2
   99 REM  DRAW 8 CHECKERBOARDS
  100 GR : POKE -16302,0
  105 A=C1: B=C2
  110 FOR X1=0 TO 20 STEP 20
  115 FOR Y1=0 TO 24 STEP 24
  120 GOSUB 1000
  125 NEXT Y1: NEXT X1
  130 POKE 775,4: POKE 779,12: CALL
      768
  135 A=C2: B=C1
  140 N=16
  145 FOR X1=0 TO 20 STEP 20
  150 FOR Y1=0 TO 24 STEP 24
  155 GOSUB 1000
  160 POKE 779,N: CALL 768
  165 N=N+4
  170 IF N>40 THEN 300
  175 NEXT Y1: NEXT X1
  180 A=C1: B=C2: GOTO 145
  299 REM  SEQUENTIAL PAGE DISPLAY
  300 FOR X=1 TO 8
  305 POKE 779,4
  310 IF X MOD 2 THEN POKE 779,8
  315 POKE 775,X*4+8: CALL 768
  320 IF X MOD 2 THEN 335
  325 POKE -16300,0
  330 GOTO 340
  335 POKE -16299,0
  340 FOR Y=1 TO PDL (0): NEXT Y
  345 NEXT X
  350 IF PEEK (-16384)>127 THEN 400
  355 GOTO 300
  399 REM  EXIT DISPLAY
  400 POKE -16300,0: POKE -16368,
      0: TEXT : CALL -936
  405 VTAB 10: PRINT "TO REPROGRAM TYP
      E 1"
  410 PRINT : PRINT "TO RESTART DISPLA
      Y TYPE 2"
  415 INPUT Y: IF Y<1 OR Y>2 THEN
      400
  420 IF Y=1 THEN 10
  425 GR : POKE -16302,0: GOTO 300
 1000 FOR X=X1 TO 19+X1: COLOR=A:
       VLIN Y1,23+Y1 AT X: NEXT X
 1005 FOR Y=Y1 TO 23+Y1 STEP H*2
 1010 Z=0
 1015 FOR X=X1 TO 19+X1 STEP W*2
 1020 P=W+X-1
 1025 IF P>19+X1 THEN P=19+X1
 1030 IF X>19+X1 THEN X=19+X1
 1035 COLOR=B
 1040 HLIN X,P AT Y+Z
 1045 NEXT X
 1050 IF Z+1=H THEN 1070
 1055 Z=Z+1
 1060 IF Y+Z>=24+Y1 THEN 1070
 1065 GOTO 1015
 1070 NEXT Y
 1075 FOR Y=H+Y1 TO 23+Y1 STEP H*
      2
 1080 Z=0
 1085 FOR X=W+X1 TO 19+X1 STEP W*
      2
 1090 P=X+W-1
 1095 IF P>19+X1 THEN P=19+X1
 1100 IF Y>23+Y1 THEN Y=23+Y1
 1105 IF X>19+X1 THEN X=19+X1
 1110 HLIN X,P AT Y+Z
 1115 NEXT X
 1120 IF Z+1=H THEN 1140
 1125 Z=Z+1
 1130 IF Y+Z>=24+Y1 THEN 1140
 1135 GOTO 1085
 1140 NEXT Y
 1145 RETURN
```

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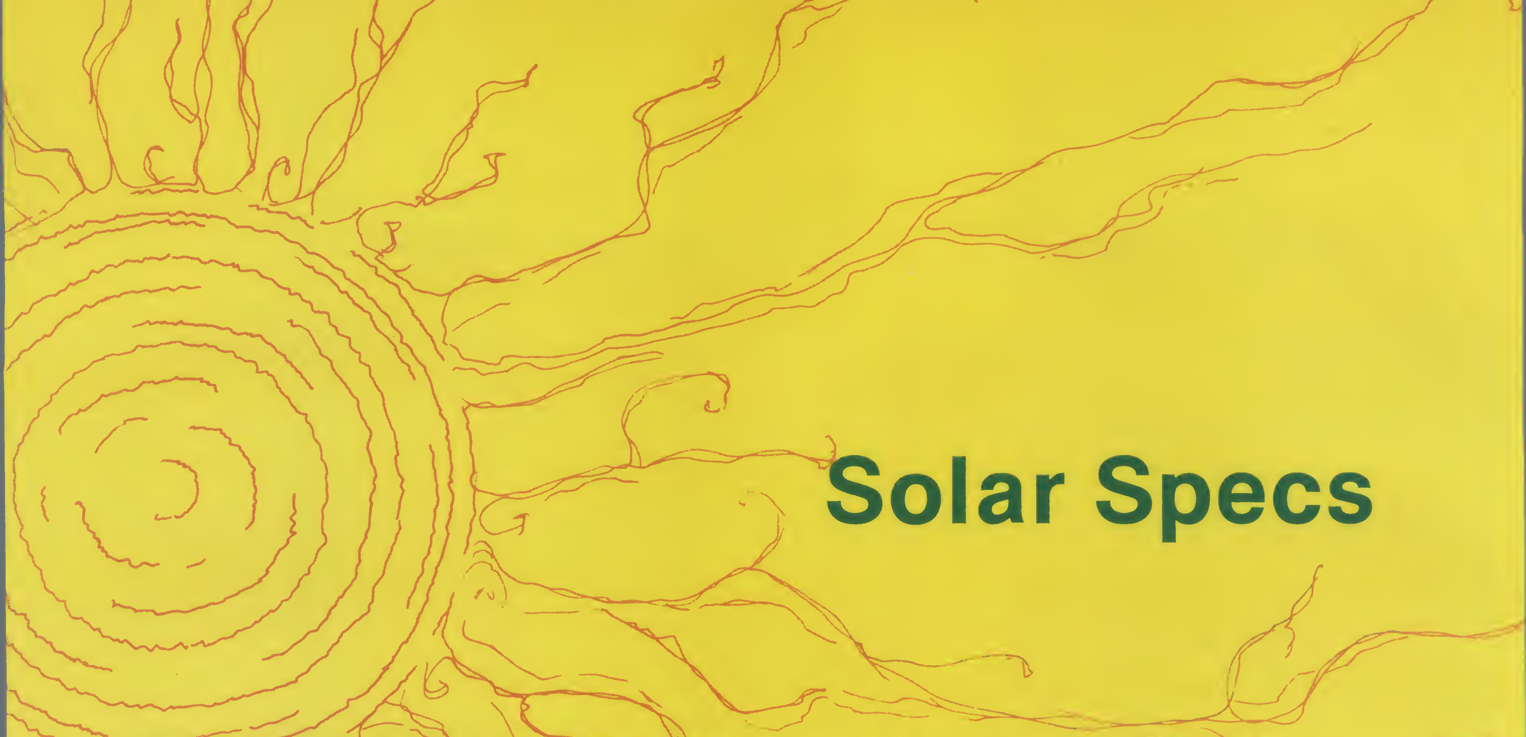

Solar Specs

Heating costs rise daily; so does the sun. This program computes solar-heat potential.

David C. Klem
2145 S. Mollera Cr.
Mesa AZ 85202

As energy costs rise monthly, many hobbyists are looking to do something tangible to reduce their power costs. In the field of solar energy, industry and hobbyists are rapidly building various types of solar heating, cooling and electric systems. Collectors of all shapes, types and sizes are appearing on the roofs of homes and businesses alike. However, no matter how different one solar system may be from another or what type of collector is

Program listing.

```
REM ******************** SOLAR. BASIC *******************************
REM WRITTEN 12/15/77 BY DAVID C.  KLEM
REM
REM THE FOLLOWING PROGRAM CALCULATES AND COMPILES DATA ON SHORTWAVE SOLAR
REM RADIATION GIVEN A MONTH OF THE YEAR IN THE NORTHERN HEMISPERE, THE LATITUDE
REM OF THE COLLECTION OF SUCH RADIATION AND THE INCLINATION OF THE COLLECTION
REM SURFACE.
REM
REM ******************************************************************************
DIM GSUBN(6), ZENITH(6), MONTH$(12), BETA(12), DECL(12), ASUBO(12)
DEF FNRAD(A)=(A*3.141659)/180
DEF FNASN(B)=ATN(B/(SQR(1-ABS(B)^2)))
DEF FNACS(C)=ATN((SQR(1-ABS(C)^2))/C)
DEF FNDEG(D)=INT((D*180)/3.141659)
DEF FNTRC(E)=INT(E*100)/100
200  PRINT: INPUT "LATITUDE IN DEGREES"; LAT
IF LAT<1 OR LAT>90 THEN 200
LAT1=LAT
LAT=FNRAD(LAT)
205  PRINT: INPUT "MONTH FOR TEST CASE"; MO
IF MO<1 OR MO>12 THEN 205
220 IF R2=1 THEN 250
FOR I=1 TO 12
READ ASUBO(I), BETA(I)
NEXT I
FOR J=1 TO 12
READ DECL(J)
DECL(J)=FNRAD(DECL(J))
NEXT J
FOR I=1 TO 12
READ MONTH$(I)
NEXT I
250 PRINT: INPUT "WILL COLLECTOR TRACK BY ALTITUDE (Y/N)", QW$
IF QW$="Y" THEN TRACK=1: GOTO 255
PRINT: INPUT "COLLECTOR TILT FROM HORIZ.  "; TILT
TILT1=TILT
TILT=FNRAD(TILT)
255 HRANGLE=105
LPRINTER
PRINT
PRINT TAB(5); "SOLAR COLLECTOR EVALUATION FOR "; LAT1; " DEGREES NORTH LATITUDE"
IF TRACK=1 THEN 260
PRINT: PRINT "COLLECTOR ANGLE "; TILT1; " DEGREES"; TAB(55); "MONTH OF "; MONTH$(MO)
GOTO 265
260 PRINT: PRINT "COLLECTOR TRACKING SUN ALTITUDE"; TAB(55); "MONTH OF "; MONTH$(MO)
265 PRINT: PRINT
PRINT "---------------------------------------------------------------------"
PRINT "! SUN TIME !  SUN POSITION  ! DIRECT SOLAR RADIATION ! DIFFUSE ! TOTAL!"
PRINT "---------------------------------------------------------------------"
PRINT "! AM   PM  ! AZI  ALT  ZEN  !  GN       INCID     GL  !   GD    ! GD+GL!"
PRINT "---------------------------------------------------------------------"
FOR I=0 TO 6 STEP 1
AM=6+I: PM=6-I
IF PM=0 THEN PM=12
HRANGLE=HRANGLE-15
ANGLE=FNRAD(HRANGLE)
OBTUSE=0
ARG1=(COS(DECL(MO))*COS(ANGLE)*COS(LAT))+(SIN(DECL(MO))*SIN(LAT))
ALT=FNASN(ARG1)
IF DECL(MO)>0 AND (1.5708-ANGLE)<DECL(MO) THEN OBTUSE=1
ARG2=(COS(DECL(MO))*SIN(ANGLE))/COS(ALT)
AZ=FNASN(ARG2)
IF OBTUSE=1 THEN AZ=3.141659-AZ
ZENITH(I)=1.5708-ALT
```

used, each solar system is dependent on the shortwave solar radiation incident on the surface of its collector for energy input.

The amount of available shortwave solar radiation (per unit area) dictates the size of the solar system's collector, given an energy need the solar system must supply. While you can easily find the theoretical amount of shortwave solar radiation available inside our atmosphere in most physics books, it is hardly practical to use this figure in designing a solar collector since large variations in solar radiation do occur.

On the other hand, you can use a pyrheliometer to measure actual solar radiation at a given location at a given time. This is a good method for determining the amount of shortwave solar radiation present but gives us no insight into how diffuse sky radiation and shortwave radiation not incident normal to the collector's surface act upon a collector's surface. Nor does it give us any information about areas other than the one we are currently considering.

The Program

The program goes beyond the limitations of these methods of estimating available solar radiation. Given the month of year, latitude of the collector and the inclination of the collector's surface from horizontal, it provides you with the following data:

1. Sun position
2. The amount, per square foot, of shortwave solar radiation incident on a collector surface facing due south (northern hemisphere)
3. The angle at which this radiation is incident
4. The amount of diffuse sky radiation available to the collector per square foot.
5. The total amount, per square foot, of shortwave radiation transmittable through normal window glass.

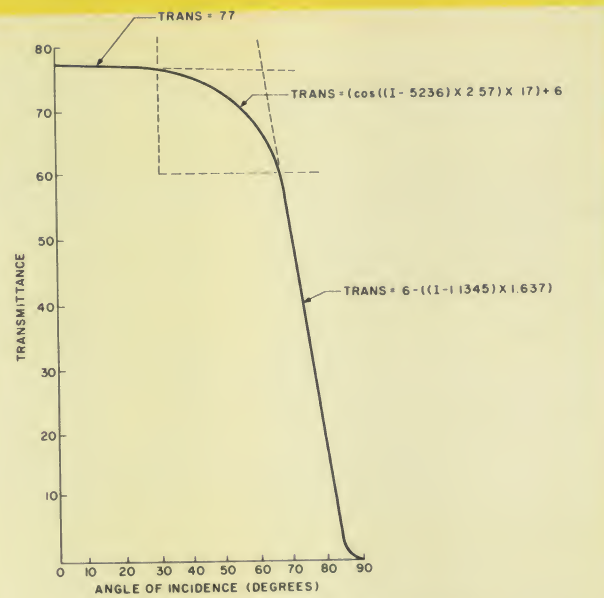

Fig. 1. Transmittance of window glass.

The program provides this data by hour of the day based on the 15th day of the month selected and also provides daily totals of the hourly information.

This program is written in CBASIC and was originally run on an Imsai 8080 with a CP/M system. Line numbering was optional on all but addressed statements. Five user-defined functions at the beginning of the program allow degree/radian conversion, arc sine and arc cosine functions and truncation. The program's input statements prompt the user for the month desired for his test case, the latitude of the solar collector, the nature of the solar collector (tracking or fixed) and, if fixed, the inclination of the collector face from horizontal.

The program uses four fields of data stored in data statements. These are the months of the year, the corresponding declination values for each month, the theoretical available shortwave radiation for each month and the atmospheric extinction

```
GSUBN(I)=ASUBO(MO)/EXP(BETA(MO)/SIN(ALT))
IF ALT<FNRAD(2) THEN GSUBN(I)=0:GOTO 290
SUMGN=SUMGN+GSUBN(I) GCOUNT=GCOUNT+1
290 IF TRACK=1 THEN ARG3=COS(AZ):GOTO 295
 ARG3=((COS(ZENITH(I))*COS(TILT))+(SIN(ZENITH(I))*SIN(TILT)))*COS(AZ)
295 INCID=FNACS(ARG3)
IF INCID<0 THEN TRANS=0 GOTO 300
GOSUB 2000
300 GSUBL=GSUBN(I)*COS(INCID)*TRANS
IF OBTUSE=1 THEN GSUBL=0
ETA=1/(6*SIN(ALT))
GSUBD=GSUBN(I)*COS(ZENITH(I))* 75*ETA
SUMGL=SUMGL+(2*GSUBL)
SUMGD=SUMGD+(2*GSUBD)
AZ=FNDEG(AZ) ALT=FNDEG(ALT) ZENITH(I)=FNDEG(ZENITH(I))
GSUBN(I)=FNTRC(GSUBN(I)) GSUBD=FNTRC(GSUBD) GSUBL=FNTRC(GSUBL)
INCID=FNDEG(INCID)
PRINT TAB(3);AM;TAB(8);PM;TAB(14),AZ,TAB(19);ALT;TAB(24);ZENITH(I),\
TAB(30),GSUBN(I),TAB(41);INCID;TAB(48),GSUBL;TAB(56);GSUBD,\
 TAB(66);INT(GSUBL+GSUBD)
 PRINT
 NEXT I
 PRINT "-----------------------------------------------------------------------"
 PRINT TAB(33);"DAILY TOTALS";TAB(48),INT(SUMGL),TAB(56),INT(SUMGD),TAB(66),\
  INT(SUMGL+SUMGD)
 PRINT PRINT PRINT PRINT
 PRINT "LEGEND ",TAB(13);"ENTRY";TAB(22);"DESCRIPTION",TAB(60),"UNITS"
 PRINT "------",TAB(13);"-----",TAB(22);"-----------",TAB(60),"-----"
 PRINT TAB(14);"AZI",TAB(22);"SOLAR AZIMUTH",TAB(60),"DEGREES"
 PRINT
 PRINT TAB(14);"ALT",TAB(22),"SOLAR ALTITUDE";TAB(60),"DEGREES"
 PRINT
 PRINT TAB(14);"ZEN";TAB(22);"SOLAR ZENITH";TAB(60),"DEGREES"
 PRINT
 PRINT TAB(14);"GN";TAB(22),"DIRECT SOLAR RADIATION"
 PRINT TAB(22);"INCIDENT ON A SURFACE";TAB(60),"BTU/SQ FT. -HR "
 PRINT TAB(22);"NORMAL TO SUNS RAYS "
 PRINT
 PRINT TAB(13);"INCID",TAB(22);"SOLAR ANGLE OF INCIDENCE"
 PRINT TAB(22),"ON COLLECTOR SURFACE";TAB(60);"DEGREES"
 PRINT
 PRINT TAB(14);"GL";TAB(22);"SOLAR RADI^ATION TRANSMITTED"
 PRINT TAB(22);"THROUGH COLLECTOR (GLASS) ";TAB(60);"BTU/SQ FT -HR "
 PRINT
 PRINT TAB(14),"GD";TAB(22);"DIFFUSF SKY RADIATION TRANSMITTED"
 PRINT TAB(22);"THROUGH COLLECTOR ";TAB(60);"BTU/SQ FT -HR. "
 PRINT
 CONSOLE
 R2=1
 PRINT INPUT "DO YOU WISH TO RUN ANOTHER EVALUATION? ";RUN$
  IF RUN$="Y" THEN SUMGL=0 SUMGD=0:SUMGN=0 TRACK=0 GCOUNT=0 DFLAG=0 GOTO 200
 GOTO 5000
 DATA 392, 142,386,. 143,378, 153,364,. 175,351,. 195,340,. 205,335,. 2,345,. 195
 DATA 362,. 181,376, 163,386,. 151,391, 143
 DATA -21 2,-12. 9,-2. 4,9. 6,18. 7,23 5,17 1,10 4,3. 3,-8. 3,-18. 3,-23. 2
 DATA JANUARY,FEBRUARY,MARCH,APRIL,MAY,JUNE,JULY,AUGUST,SEPTEMBER,OCTOBER
 DATA NOVEMBER,DECEMBER
 2000 REM GET TRANSMITTANCE FROM LOOKUP TABLE
 IF INCID<. 5236 THEN TRANS=. 77 GOTO 2100
 IF INCID>1. 1345 THEN 2050
 INC=(INCID-. 5236)*2. 57143
 TRANS=(COS(INC)* 17)+. 60
 GOTO 2100
 2050 TRANS= 6-((INCID-1. 1345)*1 637)
  IF TRANS<0 THEN TRANS=0
  2100 RETURN
  5000 END
```

coefficient for each month.

Using the program inputs and the data statements, the program solves the following equations in which these abbreviations are used.

Abbreviations

ALT—Altitude angle of sun from horizontal

D—Declination of earth's axis

L—Latitude of solar collector

H—Hour angle of the sun

Z—Zenith angle of the sun

AZ—Azimuth angle of the sun

T—Inclination of solar collector from horizontal

Gn—Direct solar radiation available normal to the surface of a collector (Btu/sq.ft. × hr.)

Gd—Diffuse sky radiation available (Btu/sq.ft. × hr.)

GI—Direct solar radiation transmittable through normal window glass (Btu/sq.ft. × hr.)

B—Atmospheric extinction coefficient (dimensionless)

I—Incidence angle of solar radiation on the collector's surface

TRANS—Transmittance factor of window glass. TRANS is derived from the curve displayed in Fig. 1. I use three equations to approximate the curve. The value of I at entry to a subroutine determines which equation is used. This subroutine is located at line 2000.

Ao—Theoretical shortwave solar radiation available inside earth's atmosphere (Btu/sq.ft. × hr.)

C—Clearness factor (assumed to be 1.0 on a clear day)

ETA—Ratio of diffuse sky radiation to direct solar radiation

Equations

ALT = acr sin (cosD cosH cosL + sinD sinL)

AZ = acr sin (cosD sinH)/(cosALT)

Z = 90 − ALT

$Gn = (Ao \times C)/e^{(B/\sin ALT)}$

I = arc cos ((cosZ cosT) + (sinZ sinT cosAZ))

GI = Gn × cosI × TRANS

Gd = .75 × Gn × cosZ × ETA

For each hour's calculations, the program prints the results in a table shown in the sample run. Hourly totals are given and are summed so daily totals can be displayed at the bottom of the hourly table. A legend is then printed below the table describing each table entry and giving its unit of measure.■

```
     SOLAR COLLECTOR EVALUATION FOR  35  DEGREES NORTH LATITUDE
COLLECTOR ANGLE  50  DEGREES                              MONTH OF APRIL

------------------------------------------------------------------------
! SUN TIME !  SUN POSITION  ! DIRECT SOLAR RADIATION ! DIFFUSE ! TOTAL!
------------------------------------------------------------------------
! AM   PM  ! AZI  ALT  ZEN  !  GN      INCID     GL  !   GD    ! GD+GL!
------------------------------------------------------------------------
  6    6     97   5    84    58.39     83      0        7.29      7
  7    5     89   17   72    204.95    89      0        25.61     25
  8    4     80   29   60    256.41    80      6.77     32.05     38
  9    3     69   41   48    279.97    69      47.11    34.99     82
  10   2     54   52   37    292.08    55      111.38   36.51     147
  11   1     31   61   28    298.07    37      179.35   37.25     216
  12   12    0    64   25    299.89    24      209.95   37.48     247
------------------------------------------------------------------------
                               DAILY TOTALS  1109     422       1531


LEGEND     ENTRY   DESCRIPTION                              UNITS
------     -----   -----------                              -----
           AZI     SOLAR AZIMUTH                            DEGREES
           ALT     SOLAR ALTITUDE                           DEGREES
           ZEN     SOLAR ZENITH                             DEGREES
           GN      DIRECT SOLAR RADIATION
                   INCIDENT ON A SURFACE                    BTU/SQ.FT -HR
                   NORMAL TO SUNS RAYS.
           INCID   SOLAR ANGLE OF INCIDENCE
                   ON COLLECTOR SURFACE                     DEGREES
           GL      SOLAR RADIATION TRANSMITTED
                   THROUGH COLLECTOR (GLASS)                BTU/SQ.FT -HR
           GD      DIFFUSE SKY RADIATION TRANSMITTED
                   THROUGH COLLECTOR                        BTU/SQ.FT -HR
```

Sample run.

CP/M* VERSION 2 FOR TRS-80★ MODEL II NOW AVAILABLE

All Lifeboat programs require CP/M, unless otherwise stated.

Software with Manual / Manual Alone

DIGITAL RESEARCH

☐ **CP/M FLOPPY DISKETTE OPERATING SYSTEM** — Packages supplied on diskette complete with 8080 assembler, text editor, 8080 debugger and various utilities plus full documentation. CP/M available configured for most popular computer/disk systems including North Star Single, Double or Quad density, Altair 8" disks, Helios II, Exidy Sorcerer, Vector MZ, Heath H17† or H89†, TRS-80†, iCOM 3712 and iCOM Micro Disk plus many other configurations available off the shelf **$145/$25**

CP/M version 2 (not all formats available immediately) **$170/$25**

☐ **MP/M*** **$300/$50**

Lower prices!

☐ **MAC** — 8080 Macro Assembler. Full Intel macro definitions. Pseudo Ops include RPC, IRP, REPT, TITLE, PAGE, and MACLIB. Z80 library included. Produces Intel absolute hex output plus symbols file for use by SID (see below) **$85/$15**

☐ **SID** — 8080 symbolic debugger. Full trace, pass count and break-point program testing system with back-trace and histogram utilities. When used with MAC, provides full symbolic display of memory labels and equated values **$70/$15**

☐ **ZSID** — As above for Z80. Requires Z80 CPU **$95/$25**

☐ **TEX** — Text formatter to create paginated, page-numbered and justified copy from source text files, directable to disk or printer **$70/$15**

☐ **DESPOOL** — Program to permit simultaneous printing of data from disk while user executes another program from the console **$45/$5**

All Microsoft prices are discounted!

MICROSOFT

☐ **BASIC-80** — Disk Extended BASIC, ANSI compatible with long variable names, WHILE/WEND, chaining, variable length file records **$300/$25**

☐ **BASIC COMPILER** — Language compatible with BASIC-80 and 3-10 times faster execution. Produces standard Microsoft relocatable binary output. Includes Macro-80. Also linkable to FORTRAN-80 or COBOL-80 code modules **$350/$25**

☐ **FORTRAN-80** — ANSI '66 (except for COMPLEX) plus many extensions. Includes relocatable object compiler, linking loader, library with manager. Also includes MACRO-80 (see below) **$400/$25**

☐ **COBOL-80** — Level 1 ANSI '74 standard COBOL plus most of Level 2. Full sequential, relative, and indexed file support with variable file names. STRING, UNSTRING, COMPUTE, VARYING/UNTIL, EXTEND, CALL, COPY, SEARCH, 3-dimensional arrays, compound and abbreviated conditions, nested IF. Powerful interactive screen-handling extensions. Includes compatible assembler, linking loader, and relocatable library manager as described under MACRO-80 **$625/$25**

☐ **MACRO-80** — 8080/Z80 Macro Assembler. Intel and Zilog mnemonics supported. Relocatable linkable output. Loader, Library Manager and Cross Reference List utilities included **$149/$15**

☐ **XMACRO-86** — 8086 cross assembler. All Macro and utility features of MACRO-80 package. Mnemonics slightly modified from Intel ASM86. Compatibility data sheet available **$275/$25**

☐ **EDIT-80** — Very fast random access text editor for text with or without line numbers. Global and intra-line commands supported. File compare utility included **$89/$15**

MICRO FOCUS

☐ **STANDARD CIS COBOL** — ANSI '74 COBOL standard compiler fully validated by U.S. Navy tests to ANSI level 1. Supports many features to level 2 including dynamic loading of COBOL modules and a full ISAM file facility. Also, program segmentation, interactive debug and powerful interactive extensions to support protected and unprotected CRT screen formatting from COBOL programs used with any dumb terminal **$850/$50**

☐ **FORMS 2** — CRT screen editor. Output is COBOL data descriptions for copying into CIS COBOL programs. Automatically creates a query and update program of indexed files using CRT protected and unprotected screen formats. No programming experience needed. Output program directly compiled by CIS COBOL (standard) **$200/$20**

☐ **HDBS** — Hierarchical Data Base System. CODASYL oriented with FILEs, SETs, RECORDs and ITEMs which are all user defined. ADD, DELETE, UPDATE, SEARCH, and TRAVERSE commands supported. SET ordering is sorted, FIFO, LIFO, next or prior. One to many set relationship supported. Read/Write protection at the FILE level. Supports FILEs which extend over multiple floppy or hard disk devices.

☐ **MDBS** — Micro Data Base System. Full network data base with all features of HDBS plus multi-level Read/Write protection for FILE, SET, RECORD and ITEM. Explicit representation of one to one, one to many, many to many, and many to one SET relationships. Supports multiple owner and multiple record types within SETs. HDBS files are fully compatible.

☐ **MDBS-DRS** — MDBS with Dynamic Restructuring System option which allows altering MDBS data bases when new ITEMs, RECORDs, or SETs are needed without changing existing data.

HDBS-Z80 version **$250/$35**
MDBS-Z80 version **$750/$35**
MDBS-DRS-Z80 version **$950/$35**
8080 Version available at $75 extra

NOTE

Z80 version requires 20K RAM. 8080 version requires 24K RAM. (Memory requirements are additional to CP/M and application program.)
When ordering HDBS or MDBS please specify if the version required is for 1) Microsoft L80 i.e. FORTRAN-80 COBOL-80 BASIC COMPILER, 2) MBASIC 4.XX or 3) BASIC-80 5.0

Lower Prices!

EIDOS SYSTEMS

☐ **KISS** — Keyed Index Sequential Search. Offers complete Multi-Keyed Index Sequential and Direct Access file management. Includes built-in utility functions for 16 or 32 bit arithmetic, string/integer conversion and string compare. Delivered as a relocatable linkable module in Microsoft format for use with FORTRAN-80 or COBOL-80, etc. **$335/$23**

☐ **KBASIC** — Microsoft Disk Extended BASIC with all KISS facilities, integrated by implementation of nine additional commands in language. Package includes KISS.REL as described above, and a sample mail list program **$585/$45**
To licensed users of Microsoft BASIC 80 (MBASIC) **$435/$45**

All Micropro prices are discounted!

MICROPRO

☐ **SUPER-SORT I** — Sort, merge, extract utility as absolute executable program or linkable module in Microsoft format. Sorts fixed or variable records with data in binary, BCD, Packed Decimal, EBCDIC, ASCII, floating, fixed point, exponential, field justified, etc. etc. Even variable number of fields per record! **$225/$25**

☐ **SUPER-SORT II** — Above available as absolute program only **$175/$25**

☐ **SUPER-SORT III** — As II without SELECT/EXCLUDE **$125/$25**

☐ **WORD-STAR** — Menu driven visual word processing system for use with standard terminals. Text formatting performed on screen. Facilities for text paginate, page number, justify, center and underscore. User can print one document while simultaneously editing a second. Edit facilities include global search and replace, read/write to other text files, block move, etc. Requires CRT terminal with addressable cursor positioning **$445/$25**

☐ **WORD-STAR/MAIL-MERGE** — As above with option for production mailing of personalized documents with mail list from Data-Star or NAD **$575/$25**

☐ **WORD-STAR Customization Notes** — For sophisticated users who do not have one of the many standard terminal or printer configurations in the distribution version of WORD-STAR **NA/$100**

☐ **WORD-MASTER** Text Editor — In one mode has superset of CP/M's ED commands including global searching and replacing, forward and backwards in file. In video mode: provides full screen editor for users with serial addressable-cursor terminal **$125/$25**

☐ **DATASTAR** — Professional forms control entry and display system for key-to-disk data capture. Menu driven with built-in learning aids. Input field verification by length, mask, attribute (i.e. uppercase, lowercase, numeric, auto dup., etc.). Built-in arithmetic capabilities using keyed data, constants and derived values. Visual feedback for ease of forms design. Files compatible with all CP/M-MP/M supported languages. Requires 32K CP/M **$350/$35**

☐ **CBASIC-2** Disk Extended BASIC — Non-interactive BASIC with pseudo-code compiler and runtime interpreter. Supports full file control, chaining, integer and extended precision variables, etc. **$109/$15**

☐ **PASCAL/M** — Compiler generates P code from extended language implementation of standard PASCAL. Supports overlay structure through additional procedure calls and the SEGMENT procedure type. Provides convenient string handling capability with the added variable type STRING. Untyped files allow memory image I/O. Requires 56K CP/M **$350/$30**

☐ **PASCAL/Z** — Z80 native code PASCAL compiler. Produces optimized, ROMable re-entrant code. All interfacing to CP/M is through the support library. The package includes compiler, companion macro-assembler and source for the library. Requires 56K and Z80 CPU. Version 2 includes all of Jensen/Wirth except variant records **$275/$25**
Version 3 Upgrade with variant records and strings expected 2/80 **$395/$25**

☐ **PASCAL/MT** — Subset of standard PASCAL. Generates ROMable 8080 machine code. Symbolic debugger included. Supports interrupt procedures and BCD arithmetic for real variables. CP/M file I/O and assembly language interface for all variables. Lacks Sets, Enumeration and Record data types. Manual explains BASIC to PASCAL conversion. Requires 32K **$95/$30**
Source for PASCAL/MT run time package. Requires MAC. (See under Digital Research.) **$50**

Structured Systems prices are discounted!

STRUCTURED SYSTEMS GROUP

☐ **GENERAL LEDGER** — Interactive and flexible system providing proof and report outputs. Customization of COA created interactively. Multiple branch accounting centers. Extensive checking performed at data entry for proof, COA correctness, etc. Journal entries may be batched prior to posting. Closing procedure automatically backs up input files. Now includes Statement of Changes in Financial Position. Requires CBASIC-2 **$899/$25**

☐ **ACCOUNTS RECEIVABLE** — Open item system with output for internal aged reports and customer-oriented statement and billing purposes. On-Line Enquiry permits information for Customer Service and Credit departments. Interface to General Ledger provided if both systems used. Requires CBASIC-2 **$699/$25**

☐ **ACCOUNTS PAYABLE** — Provides aged statements of accounts by vendor with check writing for selected invoices. Can be used alone or with General Ledger and/or with NAD. Requires CBASIC-2 **$699/$25**

Prices and specifications subject to change without notice

☐ **INVENTORY CONTROL SYSTEM** — Performs control functions of adding and depleting stock items, adding new items and deleting old items. Tracks quantity of items on hand, on order and back-ordered. Optional hard copy audit trail is available. Reports include Master Item List, Stock Activity, Stock Valuation and Re-order List. Requires CBASIC-2 and 48K CP/M **$445/$25**

☐ **ANALYST** — Customized data entry and reporting system. User specifies up to 75 data items per record. Interactive data entry, retrieval, and update facility makes information management easy. Sophisticated report generator provides customized reports using selected records with multiple level break-points for summarization. Requires CBASIC-2, 24 x 80 CRT, printer and 48K system **$225/$15**

☐ **LETTERIGHT** — Program to create, edit and type letters or other documents. Has facilities to enter, display, delete and move text, with good video screen presentation. Designed to integrate with NAD for form letter mailings. Requires CBASIC-2 **$179/$25**

☐ **NAD** Name and Address selection system — interactive mail list creation and maintenance program with output as full reports with reference data or restricted information for mail labels. Transfer system for extraction and transfer of selected records to create new files. Requires CBASIC-2 **$79/$20**

☐ **QSORT** — Fast sort/merge program for files with fixed record length, variable field length information. Up to five ascending or descending keys. Full back-up of input files created **$95/$20**

Graham-Dorian prices are discounted!

GRAHAM-DORIAN SOFTWARE SYSTEMS

☐ **GENERAL LEDGER** — An on-line system, no batching is required. Entries to other GRAHAM-DORIAN accounting packages are automatically posted. User establishes customized C.O.A. Provides transaction register, record of journal entries, trial balances and monthly closings. Keeps 14 month history and provides comparison of current year with previous year. Requires CBASIC-2. Supplied in source **$495/$35**

☐ **ACCOUNTS PAYABLE** — Maintains vendor list and check register. Performs cash flow analysis. Flexible — writes checks to specific vendor for certain invoices or can make partial payments. Automatically posts to GRAHAM-DORIAN general ledger or runs as stand alone system. Requires CBASIC-2. Supplied in source **$495/$35**

☐ **ACCOUNTS RECEIVABLE** — Creates trial balance reports, prepares statements, ages accounts and records invoices. Provides complete information describing customer payment activity. Receipts can be posted to different ledger accounts. Entries automatically update GRAHAM-DORIAN general ledger or runs as stand alone system. Requires CBASIC-2. Supplied in source **$495/$35**

☐ **PAYROLL SYSTEM** — Maintains employee master file. Computes payroll withholding for FICA, Federal and State taxes. Prints payroll register, checks, quarterly reports and W-2 forms. Can generate ad hoc reports and employee form letters with mail labels. Requires CBASIC-2. Supplied in source code **$495/$35**

☐ **INVENTORY SYSTEM** — Captures stock levels, costs, sources, sales, ages, turnover, markup, etc. Transaction information may be entered for reporting by salesman, type of sale, date of sale, etc. Reports available both for accounting and decision making. Requires CBASIC-2. Supplied in source code. **$495/$35**

☐ **JOB COSTING** — Designed for general contractors. To be used interactively with other GRAHAM-DORIAN accounting packages for tracking and analysing expenses. User establishes customized cost categories and job phases. Permits comparison of actual versus estimated costs. Automatically updates GRAHAM-DORIAN general ledger or runs as stand alone system. Requires CBASIC-2. Supplied in source **$495/$35**

☐ **APARTMENT MANAGEMENT SYSTEM** — Financial management system for receipts and security deposits of apartment projects. Captures data on vacancies, revenues, etc. for annual trend analysis. Daily report shows late rents, vacancy notices, vacancies, income lost through vacancies, etc. Requires CBASIC-2. Supplied in source code. **$495/$35**

☐ **CASH REGISTER** — Maintains files on daily sales. Files data by sales person and item. Tracks sales, overrings, refunds, payouts and total net deposits. Requires CBASIC-2. Supplied in source code **$495/$35**

☐ **tiny C** — Interactive interpretive system for teaching structured programming techniques. Manual includes full source listings **$75/$40**

☐ **BDS C COMPILER** — Supports most major features of language, including Structures, Arrays, Pointers, recursive function evaluation, linkable with library to 8080 binary output. Lacks data initialization, long & float type and static & register class specifiers. Documentation includes "C" Programming Language book by Kernighan & Ritchie **$110/$15**

☐ **WHITESMITHS C COMPILER** — The ultimate in systems software tools. Produces faster code than Pascal with more extensive facilities. Conforms to the full UNIX*** Version 7 C language, described by Kernighan and Ritchie, and makes available over 75 functions for performing I/O, string manipulation and storage allocation. Linkable to Microsoft REL files. Requires 60K CP/M **$630/$30**

☐ **POLYVUE/80** — Full screen editor for any CRT with XY cursor positioning. Includes vertical and horizontal scrolling, interactive search and replace, automatic text wrap around for word processing, operations for manipulating blocks of text, and comprehensive 70 page manual **$135/$15**

☐ **POLYTEXT/80** — Text formatter for word processing applications. Justifies and paginates source text files. Will generate form letters with custom fields and conditional processing. Support for Daisy Wheel printers includes variable pitch justification and motion optimization **$65/$15**

☐ **ALGOL-60** — Powerful block-structured language compiler featuring economical run time dynamic allocation of memory. Very compact (24K total RAM) system implementing almost all Algol 60 report features plus many powerful extensions including string handling direct disk address I/O etc. Requires Z80 CPU **$199/$20**

*CP/M is a trademark of Digital Research
**Z80 is a trademark of Zilog, Inc
***UNIX is a trademark of Bell Laboratories
****WHATSIT? is a trademark of Computer Headware
*****Electric Pencil is a trademark of Michael Shrayer Software
★ TRS-80 is a trademark of Tandy Corp

†CP/M for Heath, TRS-80 Model I and PolyMorphic 8813 are modified and must use specially compiled versions of system and applications software
Ⓜ Modified version available for use with CP/M as implemented on Heath and TRS-80 Model I computers

Ⓛ User license agreement for this product must be signed and returned to Lifeboat Associates before shipment may be made

Ⓘ This product Includes/Excludes the language
Ⓧ manual recommended in Sundries and Notions above

☐ **Z80 DEVELOPMENT PACKAGE** — Consists of (1) disk file line editor, with global inter and intra-line facilities (2) Z80 relocating assembler, Zilog/Mostek mnemonics, conditional assembly and cross reference table capabilities (3) linking loader producing absolute Intel hex disk file **$95/$20**

☐ **ZDT** Z80 Monitor Debugger to break and examine registers with standard Zilog/Mostek mnemonic disassembly displays. $35 when ordered with Z80 Development Package **$50/$10**

☐ **DISTEL** — Disk based disassembler to Intel 8080 or TDL/Xitan Z80 source code, listing and cross reference files. Intel or TDL/Xitan pseudo ops optional. Runs on 8080 **$65/$10**

☐ **DISILOG** — As DISTEL to Zilog/Mostek mnemonic files. Runs on Z80 only **$65/$10**

NEW!!

☐ **XASM-68** — Non-macro cross-assembler with nested conditionals and full range of pseudo operations. Assembles from standard Motorola MC6800 mnemonics to Intel hex **$200/$25**

NEW!!

☐ **XASM-65** — As XASM-68 for MOS Technology MCS6500 mnemonics **$200/$25**

☐ **TEXTWRITER III** — Text formatter to justify and paginate letters and other documents. Special features include insertion of text during execution from other disk files or console, permitting recipe documents to be created from linked fragments on other files. Has facilities for sorted index, table of contents and footnote insertions. Ideal for contracts, manuals, etc. Now compatible with Electric Pencil***** prepared files **$125/$20**

☐ **POSTMASTER** — A comprehensive package for mail list maintenance. Features include keyed record extraction and label production. A form letter program is included which provides neat letters on single sheet or continuous forms. Requires CBASIC-2 **$150/$15**

☐ **WHATSIT?****** Interactive data-base system using associative tags to retrieve information by subject. Hashing and random access used for fast response. Requires CBASIC-2 **$125/$25**

☐ **XYBASIC** Interactive Process Control BASIC — Full disk BASIC features plus unique commands to handle bytes, rotate and shift, and to test and set bits. Available in Integer, Extended and ROMable versions
Integer Disk or Integer ROMable **$295/$25**
Extended Disk or Extended ROMable **$395/$25**

☐ **SMAL/80** Structured Macro Assembled Language — Package of powerful general purpose text macro processor and SMAL structured language compiler. SMAL is an assembler language with IF-THEN-ELSE, LOOP-REPEAT-WHILE, DO-END, BEGIN-END constructs **$75/$15**

☐ **SELECTOR III-C2** — Data Base Processor to create and maintain multi Key data bases. Prints formatted, sorted reports with numerical summaries or mailing labels. Comes with sample applications, including Sales Activity, Inventory, Payables, Receivables, Check Register and Client/Patient Appointments, etc. Requires CBASIC-2 Version 2. Supplied in source code **$295/$20**

☐ **CPM/374X** — Has full range of functions to create or re-name an IBM 3741 volume, display directory information and edit the data set contents. Provides full file transfer facilities between 3741 volume data sets and CP/M files **$195/$10**

☐ **BASIC UTILITY DISK** — Consists of (1) CRUNCH-14 - Compacting utility to reduce the size and increase the speed of programs in Microsoft Basic and TRS-80 Basic (2) DPFUN - Double precision subroutines for computing nineteen transcendental functions including square root, natural log, log base 10, sin, arc sin, hyperbolic sin, hyperbolic arc sin, etc. Furnished in source on diskette and documentation **$50/$35**

☐ **THE STRING BIT** — Fortran character string handling. Routines to find, fill, pack, move, separate, concatenate and compare character strings. This package completely eliminates the problems associated with character string handling in FORTRAN. Supplied with source **$45/$15**

☐ **BSTAM** — Utility to link one computer to another also equipped with BSTAM. Allows file transfers at full data speed (no conversion to hex) with CRC block control check for very reliable error detection and automatic retry. We use it! It's great! Full wildcard expansions to send *.COM, etc. 9600 baud with wire, 300 baud with phone connection. Both ends need one. Standard and M versions can talk to one another. Compatible TRSDOS version also available **$150/$5**

Now TRSDOS also!

★ ★ ★ ★ ★ ★

SUNDRIES & NOTIONS

NEW!!

☐ **HEAD CLEANING DISKETTE** — Cleans the drive read/write head in 30 seconds. Diskette absorbs loose oxide particles, fingerprints, and other foreign particles that might hinder the performance of the drive head. Lasts at least 3 months with daily use. Specify 5" or 8" **$20. ea. $45. for 3**

☐ **Flippy Disk Kit** — Template and instructions to modify single sided 5¼" diskettes for use of second side in single sided drives **$12.50**

☐ **FLOPPY SAVER** Protection for center holes of 5¼" floppy disks. Only 1 needed per diskette. Kit contains centering post, pressure tool, tough 7-mil mylar reinforcing rings. Installation tools and rings for 25 diskettes **$14.95**
Re-orders of rings only **$7.95**

NEW!!

☐ **PASCAL USER MANUAL AND REPORT** — By Jensen and Wirth. The standard textbook on the language. Recommended for use by Pascal/Z, Pascal/M and Pascal/MT users **$8**

NEW!!

☐ **THE C PROGRAMMING LANGUAGE** — By Kernighan and Ritchie. The standard textbook on the language. Recommended for use by BDS C, tiny C, and Whitesmiths C users **$12**

★ ★ ★ ★ ★ ★

Shopping List No. 9

Everything on Shopping List #9 runs on 64K TRS-80 Model II

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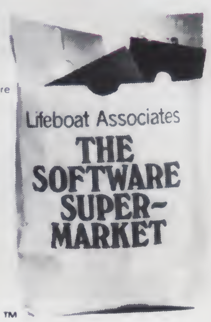

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✓ Reader Service—see page 227

Improved Sorcerer Graphics Resolution

We've been running a compendium of graphics applications for Sorcerer users.

Dr. Colin S. L. Keay
Dept. of Physics
The University of Newcastle
New South Wales, 2308
Australia

The Exidy Sorcerer personal computer has a flexible graphics capability that may be exploited to yield virtually one percent screen resolution for function plotting and pictorial representations, including animation. In terms of area, this is six times smaller than the coarse graphics ability based on the character block size, but it is still somewhat coarser than the fundamental dot size on the screen. Full-screen graphics built up from these dots is not possible, except for highly repetitive patterns, because the presence or absence of all 122,880 dots cannot be independently specified in the amount of memory available.

The Sorcerer manual shows how the dots may be individually specified to form 64 totally new patterns that reside in the 512 bytes of memory from FE00 to FFFF described as the user-graphics area. It is quite separate from the screen refresh area of 2K bytes located in memory from F080 to F7FF.

However, the Sorcerer manual supplied with the machine gives no information on the creation of symbols suitable for general graphics and pictorial use in scientific, business and recreational programs. This article aims to show how a substantial improvement on character-size block resolution may be achieved for general use over the whole screen area.

Sorcerer Display

The area in RAM dedicated to user graphics may be used to specify 64 different, independent, graphics symbols. Since 64 is two to the power of six, it is possible to subdivide the area of a character block into six smaller areas, which can be specified in any combination—64 in all.

The Sorcerer's VDU display consists of 30 lines of 64 characters, which usually has a vertical-to-horizontal size ratio of around 2/3, depending on the video monitor characteristics. If each character block is divided by six on the basis of three elements vertically by two horizontally, each elemental area will be approximately square, and the screen display will consist of 90 elements vertically by 128 horizontally, giving an average resolution of one percent.

That the elemental areas are approximately square is quite important because it preserves an aspect ratio of unity. In other words, a square is not transformed into a rectangle or a circle into an ellipse.

The problem of subdividing each block consisting of 8 × 8 dots into six equal elements is not so easy, since eight is not evenly divisible by three. Some acceptable solutions are depicted in Fig. 1. The first (1a) is easily generated and is fine for graph plotting, while the next two (1b and 1c) are essentially for creating "filled" areas for histograms, diagrams and drawings (see Photo 1).

The six elements are weighted in powers of two so that the 64 numbers from 0 to 63 represent all possible combinations of elements. For example, the combination representing a solid, right-directed arrowhead

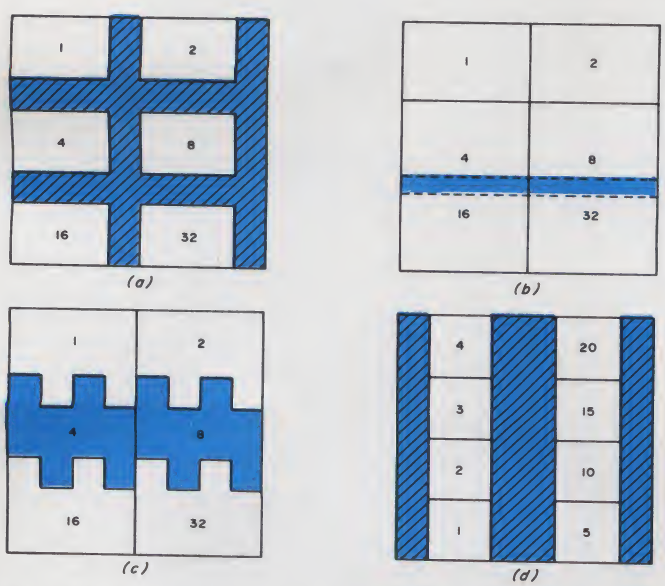

Fig. 1. Practical subdivisions of the Sorcerer character matrix for graphics purposes: (a) For independent point-plotting. Screen resolution 128 × 90. (b) For creating "filled" areas. Black/white fills unequal. (c) For creating "filled" areas. Fill ratio nearly equal. (d) For vertically single-valued point plots. Screen resolution 128 × 120.

```
700 REM *** SET UP USER-GRAPHIC 3X2 POINT-PLOT COMBINATIONS
710 P=-512
720 FOR N=0 TO 1: FOR M=0 TO 1: FOR L=0 TO 1
730 FOR K=0 TO 1: FOR J=0 TO 1: FOR I=0 TO 1
740 Q=224*I+14*J: GOSUB 780: GOSUB 790
750 Q=224*K+14*L: GOSUB 780: GOSUB 790
760 Q=224*M+14*N: GOSUB 780
770 NEXT I: NEXT J: NEXT K: NEXT L: NEXT M: NEXT N: RETURN
780 FOR R=0 TO 1: POKE P,Q: P=P+1: NEXT R: RETURN
790 POKE P,0: P=P+1: RETURN
```

Listing 1. Subroutine for creating the point-plot subdivisions of Fig. 1a as independent character blocks in the Sorcerer user-graphics area.

```
700 REM *** SET UP USER-GRAPHIC 3X2 BLOCK-FILL COMBINATIONS
710 P=-512
720 FOR N=0 TO 1: FOR M=0 TO 1: FOR L=0 TO 1
730 FOR K=0 TO 1: FOR J=0 TO 1: FOR I=0 TO 1
740 Q=240*I+15*J: GOSUB 780
750 Q=240*K+15*L: GOSUB 780
760 Q=240*M+15*N: P=P-1: GOSUB 780
770 NEXT I: NEXT J: NEXT K: NEXT L: NEXT M: NEXT N: RETURN
780 FOR R=0 TO 2: POKE P,Q: P=P+1: NEXT R: RETURN
```

Listing 2. Subroutine for creating all possible combinations of filled areas as defined in Fig. 1b.

Addr	Obj Code	Mnemonics	
0000	3E QQ	LD A, Q	Put Q in accumulator
0002	F6 RR	OR R	OR accumulator with R
0004	32 0001	LD (0001H), A	Replace Q with result
0007	C9	RET	Return to BASIC program

Table 1.

will be represented by the number 29 (16 + 8 + 4 + 1) and is given the ASCII character code 221 (192 + 29) from the range 192 to 255 allocated to the 64 user-graphics characters.

Routines

Subroutines suitable for generating these three sets of graphics characters are presented in Listings 1-3. In each case, the six nested FOR-NEXT loops generate the 64 combination of elements in ascending order with the binary-weights shown in Fig. 1. In the first subroutine (Listing 1) the numbers poked are

224D = E0H = 11100000
14D = 0EH = 00001110

or their sum

238D = EEH = 11101110

The second subroutine (Listing 2) uses similar numbers, while Listing 3 uses:

240D = F0H = 11110000
15D = 0FH = 00001111
80D = 50H = 01010000
5D = 05H = 00000101
160D = A0H = 10100000
10D = 0AH = 00001010

which correspond to the shaded (0) or intensified (1) dots in each block line according to the binary value poked in the user-graphics area. Note that in program line 790 of Listing 1 a zero, and not the value of Q, is poked in order to create a completely shaded line where it is needed within the block.

The jigsaw, or castellated, effect in the Fig. 1c block subdivision reduces the unevenness caused by the overlap of the middle and lower block elements in Fig. 1b. Although a slightly fuzzy edge appears on some elements, the shaded regions between blocks are more equal in area than in the Fig. 1b subdivision. The Fig. 1c block elements were employed to generate the picture of Snoopy shown in Photo 1. Close inspection of the VDU screen reveals the fuzzy edges of some elements, but the overall effect is quite acceptable.

In graph-plotting programs any subsequently generated points may lie within the boundary of a character block containing a previously generated point, which will be obliterated unless the two blocks are combined. This is achieved by forming the inclusive OR of the bit patterns of the ASCII character codes of the two graphic blocks.

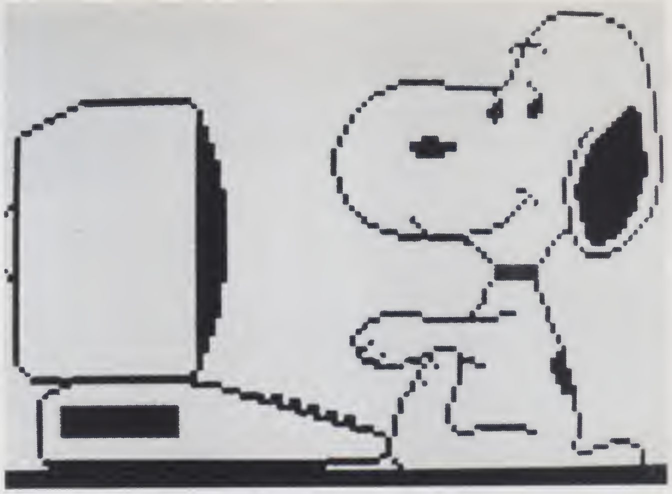

Photo 1. Snoopy (with apologies to C. Schultz) showing off his new Sorcerer. The routines in Listings 3 through 6 were used.

It is a messy operation in BASIC code because the BASIC OR operator deals only with the truth values of logical expressions.

The better approach is to utilize the USR function available in Microsoft BASIC on the Sorcerer and obtain the required operation using Z-80 machine code. This can be set up within a BASIC program by making use of the POKE command. The machine code, which can conveniently be located in the free RAM area starting at address 0000, is shown in Table 1.

This is set up by the BASIC program segment listed in Listing 4 and is called by the subroutine used to update the screen display given in Listing 5. In this subroutine, R represents the previous content of screen location P, and if it is not a symbol within the user-graphics set, it is erased by the statement in line 820. The remainder is easy to understand.

A full program for curve plotting is not given because, with help from the routines presented here, its development is not difficult and can be tailored to suit any particular requirements. However, the inclusion of a protective subroutine to confine all POKE addresses used for plotting to within the screen boundary is a safety measure that should always be included to prevent corruption of the program, stack, video scratch area or other vital areas of memory. A subroutine to set the plotted point within the confines of the screen RAM is given in Listing 6.

The "bouncing ball" curve plotted in Photo 2 employed the dot-generation subroutine of Listing 1 together with the subroutines of Listings 4 and 5.

```
700 REM *** SET UP USER-GRAPHIC 3X2 BLOCK-FILL COMBINATIONS
710 P=-512: FOR N=0 TO 1: FOR M=0 TO 1: FOR L=0 TO 1
720 FOR K=0 TO 1: FOR J=0 TO 1: FOR I=0 TO 1
730 Q=240*I+15*J: GOSUB 790: GOSUB 790
740 Q=80*I+5*J+160*K+10*L: GOSUB 790
750 Q=240*K+15*L: GOSUB 790: GOSUB 790
760 Q=80*K+5*L+160*M+10*N: GOSUB 790
770 Q=240*M+15*N: GOSUB 790: GOSUB 790
780 NEXT I: NEXT J: NEXT K: NEXT L: NEXT M: NEXT N: RETURN
790 POKE P,Q: P=P+1: RETURN
```

Listing 3. Subroutine for creating all possible combinations of filled areas as defined in Fig. 1c.

```
100 REM *** SET UP INCLUSIVE-OR ROUTINE IN MACHINE CODE
110 POKE 0,62:  REM ** 62 = 3EH = LD A,Q
120 POKE 2,246:  REM ** 246 = F6H = OR R
130 POKE 4,50: POKE 5,1: POKE 6,0:  REM ** 50 = 32H = LD 0001,A
140 POKE 7,201:  REM ** 201 = C9H = RET
150 POKE 260,0: POKE 261,0:  REM ** DEPOSIT USR FN ADDRESS
```

Listing 4. Z-80 machine code routine for combining new block elements with previous ones rather than substituting them when updating displays.

```
800 REM *** VDU SCREEN UPDATE SEQUENCE
810 R=PEEK(P)-192
820 IF (R<0 OR R>63) THEN R=0
830 POKE 1,Q: POKE 3,R:  REM ** DEPOSIT VALUES TO BE OR-ED
840 V=USR(0):  REM ** OBTAIN (Q OR R)
850 Q=PEEK(1)+192: POKE P,Q
860 RETURN
```

Listing 5. Routine for combining previous graphics character R with new character Q.

```
900 REM *** SAFETY MEASURE TO ENSURE PLOT-POINT IS WITHIN SCREEN
910 IF P>-3968 THEN 930
920 P=P+1920: GOTO 910
930 IF P<-2049 THEN 950
940 P=P-1920: GOTO 930
950 RETURN
```

Listing 6. Safety routine to avoid damage to memory contents outside the screen area.

Photo 2. Bouncing-ball curve is actually the function $Y = SIN(X) * EXP(-X/15) * SGN(SIN(X))$. The routines in Listing 1 and Listings 4 through 6 were used to produce this plot.

Photo 3. Mousetrap sales statistics for all weeks of the year. The histogram used the routines of Listing 6 and Listings 8 through 10 in its production.

Note that the axes were drawn before the points were plotted, thereby producing deliberate gaps wherever a point fell close to an axis.

It is possible to obtain a vertical graphics resolution better than 1 percent by sacrificing the ability of these routines to permit any number up to six points within the character block size to be present together. For monotonic functions of X, this feature is not required because no two points may lie above one another (provided "filled" curves are not required), so the subdivision of the character block into eight points as shown in Fig. 1(d) can be used to yield a vertical resolution of 120 points with only slight distortion of the screen aspect ratio. A subroutine for generating the 25 necessary block symbols is given in Listing 7. The symbols are called by using ASCII codes 241 through 255.

High-resolution histograms with better than half a percent accuracy may be generated very easily for up to 64 vertical columns. The character block is simply incremented line by line for a total of nine user-graphics symbols containing from zero to eight intensified lines. The symbols are given the ASCII codes 192 (completely filled block) to 200 (empty block), leaving the remaining user-graphics codes free for other uses.

A suitable subroutine to generate the histogram blocks is given in Listing 8, and the results appear in Photo 3. Labeling the axes is direct, and any required titles, descriptions and so on may be inserted quite readily by using the subroutine shown in Listing 9, which includes protection against writing outside the screen area.

It may be desirable to have a provision for writing on the screen from the keyboard without scrolling the graph. The Sorcerer has no INKEY function as has the TRS-80, but here again the USR function comes to the rescue by making use of the monitor keyboard servicing routine located at address E018H. The required machine code is shown in Table 2. It is set up and called by the routines in Listings 10a and 10b, respectively.

With the help of the various program routines presented here, the Sorcerer has a graphics capability as good or better than the majority of personal microcomputers. Only systems costing around three times as much can offer better resolution because of the unavoidable expense of providing increased video bandwidth in the display system. ■

Addr	Obj Code	Mnemonics	
0010	Cd 18E0	CALL KEYBRD	Monitor keyboard I/O entry
0013	32 0F00	LD OF, A	Get ASCII key value
0016	C9	RET	Return to program

Table 2.

```
700 REM *** SET UP USER-GRAPHIC 4X2 POINT-PLOT COMBINATIONS
710 IF PEEK(-8)=102 THEN 790
720 P=-200
730 FOR L=0 TO 4: FOR K=0 TO 4: FOR J=1 TO 4
740 M=0: IF J=5-L THEN M=1
750 N=0: IF J=5-K THEN N=1
760 Q=96*M+6*N
770 FOR I=1 TO 2: POKE P,Q: P=P+1
780 NEXT I: NEXT J: NEXT K: NEXT L
790 RETURN
```

Listing 7. Subroutine for creating the point-plot subdivisions of Fig. 1d as semi-independent character blocks in the user-graphics area.

```
700 REM *** SET UP USER-GRAPHIC HISTOGRAM BLOCKS
710 P=-512: FOR K=0 TO 8: FOR J=1 TO 8
720 Q=170: IF K=>J THEN Q=0
730 POKE P,Q: P=P+1
740 NEXT J: NEXT K: RETURN
```

Listing 8. Subroutine for creating line-by-line incremental blocks for drawing histograms with better than 0.5 percent resolution.

```
640 REM *** WRITE STRING X$ AT LOCATION P (VERTICALLY FOR V=1)
650 V=1+63*V: L=LEN(X$)
660 FOR I=1 TO L: Q=ASC(MID$(X$,I,1))
670 IF P<-3968 OR P>-2049 THEN 690
680 POKE P,Q: P=P+V: NEXT I
690 RETURN
```

Listing 9. Subroutine for writing strings horizontally or vertically on the VDU screen without scrolling.

```
a)  160 REM *** SET UP USR FUNCTION TO READ KEYS
    170 DATA 205,24,224,50,15,0,201
    180 FOR P=16 TO 22: READ Q: POKE P,Q: NEXT P

b)  870 REM *** GET KEYSTROKE IN ASCII CODE AS VALUE OF 'A'
    880 POKE 260,16: POKE 261,0: A=USR(16): A=PEEK(15): RETURN
```

Listing 10a and b. USR function and calling subroutine for entering keyboard data without scrolling the display.

EXATRON STRINGY FLOPPY Owners Association Newsletter

Secretary, Fred Waters

DATA BASE MANAGEMENT SYSTEM

Ever heard these words? If you're a professional you know what they mean. If you're a personal computing enthusiast not otherwise tied into computers or data processing, the phrase may be somewhat overpowering. Let's simplify the words without detracting from the substance: let's call it an APIP instead of a DBMS–an All Purpose Information Program. Or to bring it closer to home, why not HIH–Home Information Handler. Enough already! What's important is that a DBMS for your computer gives you, ready-made, two very useful things. First, a structure for organizing all kinds of information for almost any purpose, and second, procedures for manipulating this information in ways that are useful to you.

Let's look at an example. How about a Christmas card mailing list. To use some conventional terms, the FILE is the mailing list. It's made up of many RECORDS, each of which is normally the information about one of the individuals on the list. The entry for each individual in turn consists of several FIELDS. These are at least the name and address, and if you have a reason for making geographic distinctions, the address might be in several fields for street and number, city, state, and ZIP code. Depending on what's important to you, you might have separate fields for the years when you sent a card to this individual, years when you received one, a code word for priorities, one for other correspondence during the year, one if gifts were exchanged, etc.

So much for structure. As to the procedures or functions for manipulating the data in the file, you must be able to make a new entry, to add to or change an existing record, to delete a record, to sort out a group of records by some characteristic you're interested in, and to display or print a selected record or group of records. These procedures would be useful for the Christmas card mailing list.

Suppose that you wanted to set up and maintain a file of household and personal effects for estate or insurance purposes. Beyond the fields listed above, you might want to list for each item a cost, an appraised value, or a depreciated value. Or the quantity of identical items. Added functions might then be summing up similar fields such as current value, and applying depreciation formulas to selected items.

You get the idea. If you have a general purpose program with the STRUCTURE and FUNCTIONS already set up, you can very easily find many useful applications to suit your own personal requirements. Cataloging a stamp collection or a record collection; keeping track of your family tree; advance planning for vacations and travel; home library card file and acquisitions; general or special-purpose recipe files; and a couple of old standbys, nonetheless very useful–checkbook reconciliation and income tax data.

What's he leading up to, you say. Well, if you are the owner of an Exatron Stringy Floppy, you are automatically a member of the Exatron Stringy Floppy Owners Association–ESFOA–and goodies like the DBMS program above are readily available to you on ESF wafer. So you don't have to go through the cassette procedure. ESFOA has turned out to provide some remarkable benefits, and one of the most significant has been the enthusiastic creation and improvement of useful programs for Stringy Floppy owners. The DBMS was produced by a very talented professional programmer who relaxes at home, after a day with some giant system, by programming his TRS-80.

Bob Edmonds, pictured above, joined ESFOA shortly after the TRS-80 Stringy Floppy came on the market. He writes about the TRS-80 and ESF as one of his retirement hobbies. An amatuer programming in BASIC, he is helping ESFOA arrange for a variety of software packages (written by others) to be made available on wafers through Exatron. Software Evaluation Reports from ESF owners and indications of their software interests help guide him in shaping Exatron's software assistance.

THE STRINGY FLOPPY

If you haven't been following this column in months past, you may not have learned what the ESF is. In simple, it's a mass storage subsystem for microcomputers. In the scale of values, it does for your personal computer–TRS-80, S-100, or SS-50–much of what a disk system does, with comparable quality and reliability, at a cost much closer to that of a cassette storage device. The Stringy Floppy consists of one or more Drive modules, a Controller, power supply, all necessary cables and connectors, and miniature digital-quality tape cartridges called wafers. The ESF for the TRS-80 will load or save a 4K program in six seconds, with an extremely low error rate. The load and save rate is 7200 baud. The S-100 and SS-50 versions use double-density, and have a baud rate of 14,400, with of course twice the capacity on one wafer. The 50-foot wafer can hold 40K bytes in the TRS-80 version, and 80K bytes in the other two. For more detailed general and technical data, call the toll-free number below and ask for the data packet.

WORKSHOP CHAIRMEN

If you haven't already, go back and read about the amazing success of the ESFOA Workshops on Saturday morning in Santa Clara. And about the need for and benefits of ESFOA Workshops everywhere. Next look to your right at the facing page. This is our first published list of volunteer Workshop Chairmen. These are all Stringy Floppy owners and enthusiasts who are willing to participate in local workshops for ESF owners. They are also willing to talk to prospective ESF owners with questions beyond what is presented in the information packet, or with a desire to see a Stringy Floppy in action. Get the information packet first, and then check with your local Workshop Chairman on meetings, demonstrations, or what have you. Be assured that the owners on this list are not there purely out of altruism. We know that when owners and prospective owners get together, everyone benefits from the exchange of information, tips, techniques, program material, and anything else of common interest.

HOW TO ORDER

The ESF is assembled and tested at the factory, with a 30-day moneyback guarantee and a 1-year full warranty, and is normally in stock and ready to ship. For the fastest delivery, phone in your credit card or COD order, using the toll-free line below.

Base price for the TRS-80 ESF is $249.50 (ask about the Starter Kit): for the S-100 ESF, $289.50; for the SS-50 ESF, $250.00. The 2-for-1 Bus Extender is $15.00; the ESF-80 Monitor is $9.95. Users Manuals for all versions of the ESF and complete information packets are available at no charge. Add $3.00 for handling.

If you have any questions about these products, about Exatron, or about ESFOA, call the Hot Line. Address letters to ESFOA, 3559 Ryder Street, Santa Clara, CA 95051.

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It's Time to Draw the Line

Drawing a straight line with a computer is not as easy as it first appears. Here's how.

Nat Wadsworth
PO Box 3153
Milford CT 06460

What could be simpler than drawing a line? Lots of things, it turns out! Drawing a line by computer (yes, a plain old straight line) is not quite so simple as it might appear at first glance.

Now drawing a perfectly vertical or perfectly horizontal line on a screen is not difficult. The procedure for creating a horizontal line is simply to set Y to the value on which the line is to reside. Then X is stepped over the length of the line. For instance, on an Apple II you could draw a horizontal line across the screen by invoking the statements:

FOR X = 0 TO 39 STEP 1:PLOT X,Y:NEXT X

On a Radio Shack TRS-80 system, you could use an equivalent statement, with modified parameters, such as:

FOR X = 0 TO 127 STEP 1:SET X,Y:NEXT X

Let's not forget the Commodore PET either. On a PET system you could program:

FOR X = 0 TO 39 STEP 1:POKE A + X + Y•40,Z:NEXT X

In this statement A represents the constant value 32768, and Z stands for the code of the graphic symbol that is to be displayed by the PET.

To draw a vertical line on those machines you can set X to a fixed value and then vary Y over the desired range for the line that is to be drawn.

It turns out, however, that the cases of a perfectly vertical or perfectly horizontal lines are somewhat unusual. It is a little harder to draw a line using a computer when the end points are not on the same X or Y coordinate.

Application

Why don't you load the program shown in Listing 1 into your machine?

(Please note that from here on out in this article listings will be shown for the Apple II system. I'll assume that you can make the minor changes necessary to incorporate the routines on a TRS-80, PET or similar system. If you are using a TRS-80 Level II, this generally, requires simply substituting the SET (X,Y) directive in place of a PLOT X,Y statement. If you have a PET unit, then you will want to substitute something like POKE A + X + Y •40,Z in place of PLOT X,Y. Remember that A is equal to 32768 for a PET in the POKE formula and Z represents whatever graphics code you want displayed. The code 32 may be used if you want the display turned off at a point on the PET. Don't forget to invoke the proper "clear the screen" directive for your system in place of the GR command that does the same thing on an Apple II.)

Once you have Listing 1 loaded, modify it slightly by inserting a statement line numbered 45, which contains the directive RETURN. This little change will enable you to see something of interest related to the current discussion.

Refer to Fig. 1. Suppose we wanted to have the computer draw a line on our display screen from position 0,0 to position 39,39. How could we go about giving it directions to do such a task?

(Notice that I am using the convention typically used with video display systems of numbering the y-axis from top to bottom. Thus, the position $X = 0$ and $Y = 0$ corresponds to a point at the extreme top and left-hand corner of the display screen.)

The first half of Listing 1 gives one possible way to draw a line such as that shown in Fig. 1. The algorithm used is based on an old high-school algebra formula for the equation of a straight line in Cartesian coordinates. Do you remember it?

$Y = mX + b$

The variable m in the formula stands for the slope of the line being drawn. The variable b is the y-axis offset value. For the time being, we can forget about b, as I shall initially restrict the discussion to lines that originate at 0,0. In such cases, there is no y-axis offset.

The slope m in the formulas is simply the change in units along the y-axis over the change in units along the x-axis. For instance, if a line starts at the point X1,Y1 and ends at X2,Y2, then the slope of the line is determined to be $(Y2 - Y1)/(X2 - X1)$. Line 20 in Listing 1 uses precisely that relationship to calculate values of Y at each value of X along the line. Only integer values are used because we can only plot locations at integral points on a CRT screen.

If you execute the program in Listing 1 with a RETURN statement inserted at line 45, the program will draw a nice diagonal line. That could lead you to think that the program works just fine. You might be tempted to use it to draw a line between any two points on the screen.

Unfortunately, if you were to change line 4 of the calling sequence to $X1 = 0:X2 = 2$, you might be a little disappointed with the line drawn. As the dotted line in Fig. 1 illustrates, you would only see a few points displayed along the line! You might call that *plotting* a line, but you could hardly call it

```
1   GR:COLOR=13
4   X1=0:X2=39
5   Y1=0:Y2=39
6   GOSUB 10
9   END
10  FOR X=X1 TO X2
20  Y=INT(((Y2-Y1)/(X2-X1))*X)
30  PLOT X,Y
40  NEXT X
50  FOR Y=Y1 TO Y2
60  X=INT(Y*(X2-X1)/(Y2-Y1))
70  PLOT X,Y
80  NEXT Y
90  RETURN
```

Listing 1.

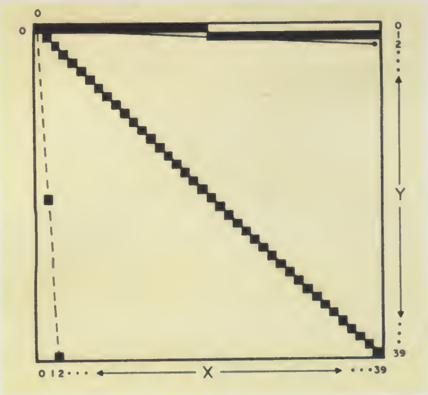

Fig. 1. Lines drawn by routine in Listing 1 when a RETURN statement is inserted at line 45.

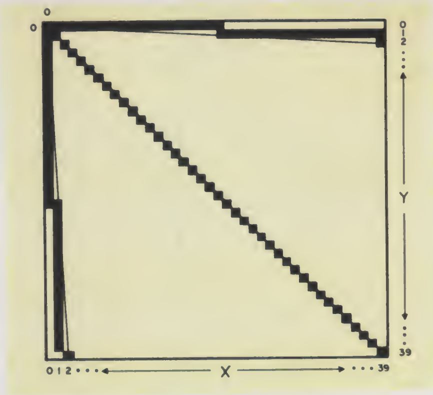

Fig. 2. Lines drawn when complete routine in Listing 1 is executed. Note that some of the lines do not appear "balanced."

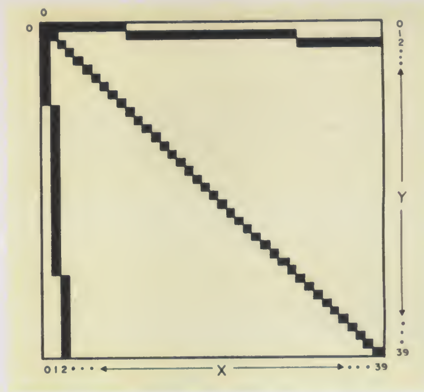

Fig. 3. Properly balanced lines drawn by routines shown in Listings 2 and 3.

drawing a line.

Restoring line 4 in Listing 1 to its original value, X1 = 0: X2 = 39, and then changing line 5 to read Y1 = 0, Y2 = 2 would yield the nearly horizontal line shown in Fig. 1. That line is not exactly perfect. For one thing, the proper end point of the line does not get displayed by the routine!

The reason a very good line is not drawn is that with a RETURN statement at line 45, the program only calculates and displays points along the Y axis at discrete values of X. When X only goes from 0 to 2, only a few points are displayed, regardless of how far the line goes in the Y direction.

We can improve the situation somewhat by removing the RETURN statement at line 45. Now the program will effectively fill in the gaps between points because it will also plot locations along the x-axis for discrete values of Y. Fig. 2 illustrates the improvement you can obtain when the entire program in Listing 1 is utilized.

Modification

The line shown in Fig. 2 might be considered satisfactory by some, especially since the actual end point of the line is properly displayed. Furthermore, the display seems to show a pretty good approximation to the path of a line between the two end points. However, there is still a little problem with the line. Can you see something amiss?

The problem is a result of an anomaly that arises from using digital computer techniques. The algorithm being used in Listing 1 does not plot a point until a discrete integer value is reached. Thus, for the line that goes from X1 = 0 to X2 = 39 (the nearly horizontal line in Fig. 2), the line will be displayed along the y-axis with Y = 0 until Y reaches the value 1. It is then held steady at the value 1 until Y reaches 2.

Y reaches 2 just at the point that the line ends. This causes the line to appear improperly balanced. It is "weighted" in the example towards the lower values of X.

A smoother line can be drawn by slightly modifying the algorithm of Listing 1 so that it appears as shown in Listing 2. Compare lines 20 and 60 in those two listings. The simple technique of rounding off values to the next higher coordinate, by adding 0.5 to the product of the slope and the opposite axis' value, results in the improvement shown in Fig. 3. Figure 3 is about the best you are going to be able to do when drawing straight lines on a low-resolution display device!

What about Perfectly Straight Lines?

Are we finished yet? Not quite. The routine shown in Listing 2 is only good for a limited set of lines, i.e., those starting at the coordinate X = 0,

```
1    GR:COLOR=13
4    X1=0:X2=2
5    Y1=0:Y2=39
6    GOSUB 10
9    END
10   FOR X=X1 TO X2
20   Y=INT(((Y2-Y1)/(X2-X1))*X)+0.5)
30   PLOT X,Y
40   NEXT X
50   FOR Y=Y1 TO Y2
60   X=INT((Y*(X2-X1)/(Y2-Y1))+0.5)
70   PLOT X,Y
80   NEXT Y
90   RETURN
```

Listing 2.

```
1    GR:COLOR=13
2    X1=INT(RND(1)*38):X2=INT(RND(1)*38):IF X1=X2 THEN 2
3    X1=INT(RND(1)*38):X2=INT(RND(1)*38)
5    Y1=INT(RND(1)*38):Y2=INT(RND(1)*38)
6    GOSUB 5000
7    COLOR=RND(1)*14+1
8    GOTO 2
9    END
5000 IF X2>X1 THEN A=1
5010 IF X2<X1 THEN A=-1
5020 IF X2=X1 THEN 5070
5030 FOR X=X1 TO X2 STEP A
5040 Y=INT((((Y2-Y1)/(X2-X1))*(X-X1))+0.5)+Y1
5050 PLOT X,Y
5060 NEXT X
5070 IF Y2>Y1 THEN B=1
5080 IF Y2<Y1 THEN B=-1
5090 IF Y2=Y1 THEN 5140
5100 FOR Y=Y1 TO Y2 STEP B
5110 X=INT(((Y-Y1)*(X2-X1)/(Y2-Y1))+0.5)+X1
5120 PLOT X,Y
5130 NEXT Y
5140 RETURN
```

Listing 3.

Y = 0. It also has a critical weakness in that it cannot handle the cases of lines that run perfectly horizontal or vertical! (Can you see why?)

What we really want to end up with is a general procedure that can display a straight line starting and ending anywhere on a screen. To accomplish this, it is necessary to pick up that offset variable "b" that I said we could forget about a while earlier in the discussion of the formula $Y = mX + b$. In order to enable the algorithm to handle the special cases of perfectly horizontal or vertical lines, it is necessary to add a few conditional tests.

(Did you spot the problem here? If X or Y does not change value at all over the length of the line, the divisor of the slope variable "m" in the equation will be zero in one part of the program. You know better than to attempt to get your computer to divide by zero!)

Listing 3 shows a general-purpose line-drawing routine that fills the bill. The general case algorithm starts at line 5000. It expects the starting and ending coordinates of the line that is to be drawn to have been established as the values X1,Y1 and X2,Y2. Fig. 3 illustrates the improved lines that this routine draws.

You can use the subroutine at line 5000 as the starting point for more complex graphics programs. It will draw any straight line you want. Just tell it the starting and ending points. Think you can use such a subroutine in your personal computing system?

To get you started on enjoying your new capability, take a look at the calling sequence I have shown in Listing 3. You can use it on an Apple II system to continuously draw lines of random length and direction in randomly selected colors. Run the program as shown and watch your display screen fill up with a continuously changing pattern of colors.

Don't have a color display system? You can still coax black and white units into providing an interesting display by changing the calling sequence so that lines are alternately drawn in white and black. For instance, on a TRS-80 system add a similar line-drawing subroutine that utilizes the RESET (X,Y) statement to draw black (blank) lines. With a PET you can get interesting displays by changing the character being POKEd on the screen each time a new line is drawn.

I am sure you can come up with your own ideas using BASIC's RND (random) function to create such artistic patterns. Of course, the real value of the algorithm lies in its general line-drawing capability. ■

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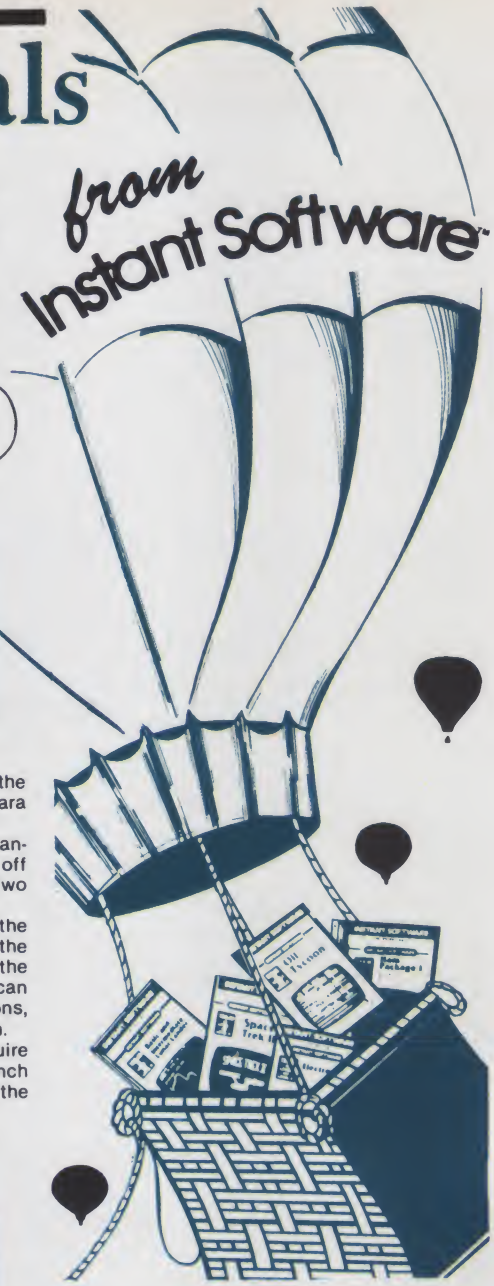

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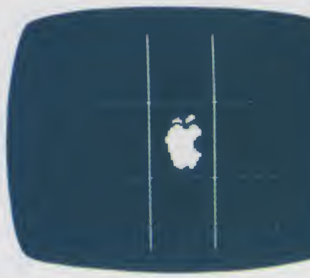

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An Operator-Oriented Data Base Management System

This three-part series concludes with programs to sort and print the data.

Joel Shapiro
491 Kenilworth Court
Des Plaines IL 60016

In the last installment of this three-part article, we examined several of the BASIC programs that make up an operator-oriented data base management system. This month, we conclude the series with a look at the remaining programs, which are used to sort and print the data.

Sorting the Data

The SORTFILE program (Listing 1) provides the sorting function. This program is called from PROGRAMS, but no variables are passed to it through the system. Instead, the information required for the sort is read from the first five records, and additional information is supplied by the operator. The reason for this is that variables passed by other programs in the chaining action still occupy memory and may not be used. I wanted as much available memory as possible for this program.

The program will generate an index file, which will have the record numbers of the master file sorted into the required sequence. Rather than write a full sort-merge disk program, where the data must be transferred from the master file to the index file as a part of the sort routine, I elected to use the system memory (array A%) to retain the data. This allows the sort to be accomplished in a much shorter period than it would with the disk sort-merge.

The Micropolis disk system verifies all file data when a record is written. Although this is a good system (I've never lost a bit!), it does take time. This, plus the head access time, could make the sort a nuisance rather than a desirable feature. The sort is completed and then the index file is written. There is enough memory to accomplish this.

Up to ten levels can be sorted. The fields and their sequence

Listing 1. SORTFILE.

```
10!     SORT PROGRAM
20!   BY JOEL SHAPIRO 6/79
30!
40!     FILENAME-SORTFILE
50!
61 SIZES(5,3,250,5300):MEMEND16RB7FF
62 DEFFAA=16R6B9:DEFFAB=16R6C2
63 DIM B$(15,4),F$(30,30),G$(5,250),X$(30,25),Y$(30,2),X(30),Y(30),Z$(30,3),A%(1225),B%(10),J$(2,250)
64 STRINGCHAR$(255):Y$='!'
65 RESTORE66:FORI=1TO15:READB$(I):NEXTI
66 DATA'\','D','N',' ',':',',','/','-','*','S',',','%','DATE','NAME','AMT.'
80!
100 GOSUB302:PRINT'SORT PROGRAM':PRINT:PRINT'DO YOU WISH TO:':PRINT
110 PRINT' 1) CREATE A NEW INDEX FILE':PRINT' 2) SORT MASTER FILE'
120 PRINT' 3) RETURN TO DIRECTORY':PRINT
150 INPUT'SELECT FUNCTION YOU DESIRE';A:A=INT(A):IFA<1ORA>3THEN150
160 ONAGOTO2000,2070,2720
302 POKE(16R6B8)=65:D=FAA:POKE(16R6B8)=41:D=FAA:RETURN
330 POKE(16R64E)=16R80:RETURN
331 POKE(16R64E)=16R00:RETURN
500!
502 IFA3=1THENGOSUB995:PRINT'SAME FILE?':GOSUB998:GOSUB990:IFA$='Y'THENRETURN
510 GOSUB995:PRINT'ENTER NAME OF FILE'
512 PRINT'OR \ TO EXIT PROGRAM'
515 GOSUB999:INPUTN$:IFN$=B$(1)THEN100
520 FORN9=0TO1:A$=MID$(STR$(N9),2,1):OPEN1A$+':'+N$ ERROR540
530 N$=A$+':'+N$:T=FREETR(1):CLOSE1:A3=1:RETURN
540 IFERR=4ORERR=7THENNEXTN9
550 GOSUB995:PRINTERR$:PRINT'STOPPED':PRINT'MAKE CORRECTION':GOSUB999:GOSUB997:GOTO500
560 GOTO510
600!
603 GOSUB330:PRINT'ILLEGAL INPUT!  RE-ENTER':GOSUB331:RETURN
607 GOSUB998:PRINTTAB(10)'PROCESSING DATA':GOSUB999:RETURN
612 CLOSE1:GOSUB330:PRINT'DISK ERROR!':PRINTERR$:GOSUB331:GOSUB997:RETURN
830!   PARSE G$(R1)
831 IFI>10THENR1=3
832 IFI>20THENR1=4
834 J=LEN(G$(R1)):X=INDEX(G$(R1),Y$):IFX=0THEN838
836 G$=LEFT$(G$(R1),X-1):G$(R1)=RIGHT$(G$(R1),J-X)
838 RETURN
840!   PARSE G$ (TITLE, FIELD, CODE)
```

for sorting are retained in the B%(X) array. The actual sort is done starting at line 2350 and, as you can see, it's basically an S/M sort modified for disk. The loop that controls the multiple-level feature begins at line 2520 and scans the selected fields as the data is processed. It compares all of the fields as each record is read from the file and then determines if an exchange is required. As you can see, the comparisons must be made in three different ways, dependent upon the type of field and data in the field.

If a date field has been accessed, the compare will be made in lines 2540–2610. It is necessary that we parse the date string and compare year, month and day, in that order, for proper sorting. Strings are compared in lines 2670–2690, and numerical and dollar fields are compared in lines 2640–2660.

Exchanges are made in line 2700. Remember that we are exchanging the record numbers retained in the A%(X) array and not the master file!

As part of the sort routine, we develop variable B1, which is really a value of half the number of records still to be sorted. In line 2390 I'm printing the number of the screen to let people know that the sort routine is working. This is a kind of countdown display—the closer you get to 0, the closer you are to completion. Line 2390 can be eliminated without any effect on the sort.

When the sort is completed, the operator is asked for the name of the index file and the file is accessed. Line 2220 checks for enough space in the file for the index information. If there is not enough space, the operator is permitted to create another file on another disk without losing the sort data. Once it has been established that enough space exists, the data in the sorted array is transferred to the index file.

The structure of the index file is different from the data files, since it is used for another purpose and will not read back correctly should you access it as a data file. Data is written into the index file in strings of up to 25 record numbers with a backslash delimiter for each record number. This way, data is stored in a ratio of 25 to 1 when compared with the data strings, and the index file will use little space on the disk.

Because the master file is not changed, many index files can be made for the same file for the many types of sort you may desire; but remember that when data is added, changed or deleted, a new sort will have to be made. If there is only one type of

```
844 X=0:Y$(I)=RIGHT$(G$,2):G$=LEFT$(G$,LEN(G$)-2)
846 X=INDEX(G$,B$(1)):X$(I)=LEFT$(G$,X-1)
848 Z$(I)=MID$(G$,X+1,LEN(G$)-X)
849 RETURN
850!   LOAD Y ARRAY WITH FIELD DATA
851 Y(1)=2:IFVAL(F$(2))<2THENRETURN
852 FORI=2TOVAL(F$(2)):Y(I)=Y(I-1)+VAL(Z$(I-1)):NEXTI:RETURN
924 FORI=1TO5:G$(I)="":NEXTI:RETURN
990 INPUT"( Y OR N )";A$:IFA$<>"Y"ANDA$<>"N"THEN990
991 RETURN
995 PRINTREPEAT$(CHAR$(13),25):RETURN
996 PRINTREPEAT$(CHAR$(61),39):RETURN
997 PRINT:INPUT"PRESS RETURN TO CONTINUE";A:RETURN
998 PRINTREPEAT$(CHAR$(13),9):RETURN
999 PRINTREPEAT$(CHAR$(13),7):RETURN
1000!   READS PARAMETER DATA AND SETS ARRAYS
1001 GOSUB302:GOSUB500:OPEN1N$ERROR1002:ATTRS(1)=0:GOTO1003
1002 GOSUB612:GOTO1001
1003 GOSUB1110:GOSUB302:GOSUB1030:GOSUB302:GOSUB850:RETURN
1010!   DISPLAY RECORDS 2-4 TITLE DATA
1011 L=0:FORI=1TOVAL(F$(2)):L=L+1:IFL=15THENL=0:GOSUB997
1012 IFI=1THENPRINTTAB(10)"RECORD #2"
1013 IFI=11THENPRINTTAB(10)"RECORD #3"
1014 IFI=21THENPRINTTAB(10)"RECORD #4"
1017 PRINTI;TAB(6)X$(I);TAB(25)Z$(I);TAB(31)Y$(I)
1018 NEXTI:IFL=0THENRETURN
1019 GOSUB997:RETURN
1030!   DISPLAY FILE HEADING
1032 PRINT"HEADING DATA FOR FILE - ";RIGHT$(N$,LEN(N$)-2):PRINT
1034 PRINT"CODE = ";F$(1):PRINT"NUMBER OF FIELDS = ";F$(2):PRINT"SPECIAL FILENAME = ";F$(7)
1036 PRINT"DATE CREATED = ";F$(6):PRINT"LAST UPDATE = ";F$(8):PRINT:IFG$(5)=""ORG$(5)="0"THEN1038
1037 PRINT"RECORD #5 MESSAGE":PRINTG$(5)
1038 IFVAL(F$(3))>1THENPRINTF$(3);" RECORDS CODED FOR DELETION"
1039 PRINT"DATA RECORDS IN FILE";SIZE(1)-5:PRINT"RECORDS REMAINING ON DISK ";T*16:PRINT:GOSUB997:RETURN
1050!   DISPLAY DATA (G$(1))
1052 FORI=1TOVAL(F$(2))
1054 G$(2)="":G$(2)=MID$(G$(1),Y(I),VAL(Z$(I)))
1055 PRINTI;TAB(5)X$(I);TAB(25)G$(2)
1056 IFI=15ORI=2*15THENGOSUB997
1058 NEXTI:RETURN
1060!   PULLS OUT SPECIFIC FIELD FOR SEARCH
1061 G$(2)="":G$(2)=MID$(G$(1),Y(A),VAL(Z$(A))):RETURN
1065 J$(2)="":J$(2)=MID$(J$(1),Y(A),VAL(Z$(A))):RETURN
1100!   READ RECORDS 1-5 FROM FILE
1101 FORI=1TO5:GET1RECORDIG$(I):NEXTI:RETURN
1110!   READ G$(1-5)FROM FILE:LOAD ARRAYS
1112 GOSUB1100:GOSUB607:R1=1:FORI=1TO30:GOSUB834:F$(I)=G$:NEXTI
1114 R1=2:FORI=1TOVAL(F$(2)):GOSUB830:GOSUB840:NEXTI
1119 RETURN
1300!   WRITE G$(1-5) TO DISK
1301 FORI=1TO5:PUT1RECORDIG$(I):NEXTI:RETURN
2000 GOSUB302:PRINT"ENTER NAME OF NEW FILE":INPUTN$:IFLEN(N$)>10THENGOSUB603:GOSUB997:GOTO2000
2010 PRINT"ENTER DISK DRIVE # FOR FILE":INPUTA$:IFVAL(A$)>1THENGOSUB603:GOSUB997:GOSUB302:GOTO2010
2020 N$=B$(3)+B$(5)+A$+B$(5)+N$
2030 OPEN1N$ERROR2060:CLOSE1:GOSUB995:PRINT"NEW FILE CREATED":GOSUB998:GOSUB997:GOTO80
2040 IFA5=5THENA5=0:GOTO2200
2050 GOTO80
2060 GOSUB330:PRINT"DISK ERROR!":PRINTERR$:PRINT"CORRECT AND;":GOSUB997:GOTO2000
2070 A3=0:GOSUB302:PRINT"ENTER NAME OF MASTER FILE":GOSUB500:OPEN1N$
2080 GOSUB1003:GOSUB924:GOSUB1050
2090 PRINT:PRINT"SELECT FIELDS FOR SORTING. THE FIRST":PRINT"FIELD SELECTED WILL BE THE PRIMARY"
2100 PRINT"FIELD; OTHERS, IN ORDER OF SELECTION":PRINT"WILL DETERMINE THE OTHER SORTING"
2110 PRINT"LEVELS. ENTER A \ AFTER THE FINAL FIELD":PRINT"SELECTION WHEN 'FIELD' IS REQUESTED"
2120 PRINT:PRINT"UP TO 10 LEVELS CAN BE SELECTED"
2130 GOSUB997:PRINT"DO YOU WISH TO REVIEW FIELD SELECTION":PRINT"AGAIN":GOSUB990:IFA$="Y"THENGOSUB1050:GOSUB997:GOTO2090
2140 GOSUB302:FORI=1TO10
2150 PRINT"LEVEL";I:INPUT"FIELD";A$:IFA$=B$(1)THENK1=I-1:GOTO2180
2160 IFVAL(A$)<0ORVAL(A$)>VAL(F$(2))THENGOSUB603:GOSUB997:GOTO2150
2170 B%(I)=VAL(A$):NEXTI:K1=I
2180 GOTO2340
2190 K1=SIZE(1):CLOSE1
2200 GOSUB302:PRINT"INSERT DISK WITH INDEX FILE INTO DRIVE":GOSUB997
2210 A3=0:GOSUB500:OPEN1N$ CLEAR ERROR2330
2220 ATTRS(1)=0:IFINT(((K1/25)/16)+1)>FREETR(1)THENCLOSE1:GOTO2290
2230 G$="":I1=0:FORI=1TOK1:G$=G$+STR$(A%(I))+B$(1)
2240 I1=I1+1:IFI1=25THENGOSUB2710
2250 NEXTI:GOSUB2710
2260 ATTRS(1)=3:CLOSE1
2270 GOSUB302:PRINT"INDEX FILE COMPLETED":PRINT:PRINT"ANY MORE FILES TO SORT":GOSUB990:IFA$="Y"THENPLOADG"SORTFILE"
2280 GOTO2720
2290 GOSUB302:PRINT"NOT ENOUGH SPACE ON DISK FOR YOUR":PRINT"INDEX FILE. DO YOU WANT TO CREATE":PRINT"ANOTHER INDEX FILE":GOSUB990
2300 IFA$="Y"THENA5=5:GOTO2000
2310 GOSUB302:PRINT"DO YOU WISH TO RETURN TO THE INDEX":PRINT"FILE WRITE PROGRAM":GOSUB990:IFA$="Y"THEN2200
2320 GOTO80
2330 GOSUB302:GOSUB330:PRINT"DISK ERROR!":PRINTERR$:GOSUB331:PRINT"CORRECT ERROR AND":GOSUB997:GOTO2200
2340 GOSUB607:FORI=1TO1225:A%(I)=I:NEXTI
```

```
2350 B=SIZE(1)+1
2360 B1=B-5
2370 B1=INT(B1/2)
2380 IFB1=0THEN2190
2390 PRINTB1;:!  LETS PEOPLE KNOW IT'S WORKING
2400 B2=6:B3=(B-1)-B1
2410 B4=B2
2420 B5=B4+B1
2430 GOTO2510
2440 GOSUB2700
2450 B4=B4-B1
2460 IFB4<6THEN2480
2470 GOTO2420
2480 B2=B2+1
2490 IFB2>B3THEN2370
2500 GOTO2410
2510 GET1RECORDA%(B4)G$(1):GET1RECORDA%(B5)J$(1)
2520 FORI1=1TOK1:A=B%(I1):GOSUB1061:GOSUB1065
2530 IFLEFT$(X$(B%(I1)),4)<>B$(13)THEN2630
2540 IFRIGHT$(G$(2),2)<RIGHT$(J$(2),2)THEN2480
2550 IFRIGHT$(G$(2),2)=RIGHT$(J$(2),2)THEN2570
2560 GOTO2440
2570 IFLEFT$(G$(2),2)<LEFT$(J$(2),2)THEN2480
2580 IFLEFT$(G$(2),2)=LEFT$(J$(2),2)THEN2600
2590 GOTO2440
2600 IFMID$(G$(2),4,2)<=MID$(J$(2),4,2)THEN2480
2610 GOTO2440
2620 GOTO2690
2630 IFLEFT$(Y$(B%(I1)),1)<>B$(2)ANDLEFT$(Y$(B%(I1)),1)<>B$(3)THEN2670
2640 IFVAL(G$(2))<VAL(J$(2))THEN2480
2650 IFVAL(G$(2))>VAL(J$(2))THEN2440
2660 GOTO2690
2670 IFG$(2)<J$(2)THEN2480
2680 IFG$(2)>J$(2)THEN2440
2690 NEXTI1:GOTO2480
2700 A%=A%(B4):A%(B4)=A%(B5):A%(B5)=A%:RETURN
2710 PUT1G$:G$="":I1=0:RETURN
2720 PLOADG"DATABASE"
```

Listing 2. REPORT.

```
10!   REPORT GENERATOR PROGRAM
20!     BY JOEL SHAPIRO 6/79
30!
40!        FILENAME-REPORT
50!
61 SIZES(5,3,250,6450):MEMEND16RB7FF
62 DEFFAA=16R6B9:DEFFAB=16R6C2
63 DIM B$(15,4),F$(30,30),G$(5,250),X$(30,25),Y$(30,2),X(30),Y(30),Z$(30,3)
64 STRINGCHAR$(255):Y$="|"
65 RESTORE66:FORI=1TO15:READB$(I):NEXTI
66 DATA"\","D","N"," ",":",",","/","-","*","S",".","%","DATE","NAME","AMT."
68 DIME%(30),B%(10),C%(30),C$(30,16),D%(31)
80!
100 GOSUB302:PRINT"   ** REPORT GENERATOR PROGRAM **":PRINT
110 PRINT"FUNCTIONS AVAILABLE":PRINT
120 PRINT" 1) PRINT LISTS, REPORTS, ETC.":PRINT" 2) OPEN"
130 PRINT" 3) OPEN"
140 PRINT" 4) OPEN":PRINT" 5) OPEN":PRINT" 6) OPEN"
150 PRINT" 7) OPEN":PRINT" 8) OPEN":PRINT" 9) OPEN"
160 PRINT"10) RETURN TO DIRECTORY"
190 PRINT:PRINT"ENTER FUNCTION YOU DESIRE":INPUTA:IFA<1ORA>10THEN190
200 ONAGOTO1500,2500,3000,5000,5000,5000,5000,5000,5000,9950
302 POKE(16R6B8)=65:D=FAA:POKE(16R6B8)=41:D=FAA:RETURN
330 POKE(16R64E)=16R80:RETURN
331 POKE(16R64E)=16R00:RETURN
500!
510 GOSUB995:PRINT"ENTER NAME OF ";:IFA=1THENPRINT"MASTER FILE"
511 IFA=2THENPRINT"INDEX FILE"
512 PRINT"OR \ TO EXIT PROGRAM"
515 GOSUB999:INPUTN$:IFN$=B$(1)THEN100
520 FORN9=0TO1:A$=MID$(STR$(N9),2,1):OPENAA$+":"+N$ ERROR540
530 N$=A$+":"+N$:T=FREETR(A):CLOSEA:RETURN
540 IFERR=4ORERR=7THENNEXTN9
550 GOSUB995:PRINTERR$:PRINT"STOPPED":PRINT"MAKE CORRECTION":GOSUB999:GOSUB997:GOTO500
560 GOTO510
600!
603 GOSUB330:PRINT"ILLEGAL INPUT!  RE-ENTER":GOSUB331:RETURN
607 GOSUB998:PRINTTAB(10)"PROCESSING DATA":GOSUB999:RETURN
612 CLOSE1:GOSUB330:PRINT"DISK ERROR!":PRINTERR$:GOSUB331:GOSUB997:RETURN
614 GOSUB302:PRINT"DO YOU WANT;":PRINT:RETURN
830!   PARSE G$(R1)
831 IFI>10THENR1=3
832 IFI>20THENR1=4
834 J=LEN(G$(R1)):X=INDEX(G$(R1),Y$):IFX=0THEN838
```

sort required for a report, it's no problem, but the multitude of sorting options can increase the time involved in getting the report if used without enough discretion. I make it a habit to update the file as much as possible before sorting.

Producing Printed Reports

The REPORT program (Listing 2) is probably the most complicated to understand, as it uses the result of the other programs to provide its function. Additional arrays (line 68) are used for the program, and no data is passed from PROGRAMS for its operation.

In this program, once the field sequence and basic options have been chosen, they can be retained on the disk and don't have to be reentered for each new report unless there are changes. Line 1510 detects a previous format and asks if this is to used. If it is, then the portion of the program that obtains the format data from the operator is skipped. Lines 1540–1790 get the input from the operator; array variable F$(4) retains the fields to be printed and their sequence.

Having up to 30 field numbers retained in a variable with a maximum string length of 30 characters presented a problem; however, it can be done by using the ASCII equivalent of the number. Lines 1640 and 1650 provide this conversion for both the fields to be printed, F$(4), and the fields to be totaled, F$(9).

The options desired are the result of yes and no answers in lines 1690–1790. Each yes answer is converted to 2, and each no answer is converted to 1. This information is converted to a string and retained in F$(5).

If the operator elected to use the format previously used in a report, the aforementioned array elements will have been filled with the file information, and operation can continue from line 1800. The operating arrays are filled with the parsed data exactly as if it were new input. The F$(X) array now has all the information, which can then be transferred to record 1 of the file for future use.

Lines 1860–1890 format the dollar fields and retain the information in the C$(X) array. It is done here rather than in the data input program so less space is required in the data file. Array E%(X) retains the field numbers for the fields to be totaled. This is determined by the subroutines in lines 1610–1640. The C%(X) array holds the field selection and sequence.

The subroutine in lines 1400–1416 provides the tabs for the print routine. These are determined by lines 1413 and 1414 and are retained in array D%(X). Lines 1910–2090 allow selection of a few more options. Data regarding these is retained in variables X1–X9, which have been allocated for this purpose. Not all of them are used at this time.

After all of this has happened, control is transferred to the PRINTER program.

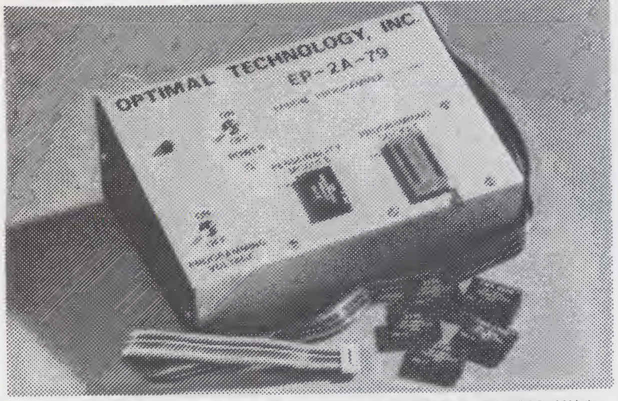
The PRINTER program (Listing 3) has the final word in the system's operation. It is not a complex program, as most of the decisions have been made in previous programs, but it has some lines of note. Two additional arrays are dimensioned in line 100.

The A%(X) array is used to retain the record numbers of the master file as read from the index file. If an index file isn't used, then the records will be accessed sequentially. The E(X) array is used to total the fields as determined in the E%(X) array.

The subroutine in lines 1420–1429 takes care of reversing the first and last names if that option is used. Line 3090 bypasses the print routine if the line is coded for deletion.

Variable X4 contains the field used for limits if this option is used, and line 3110 checks to see that the data is between the upper and lower limit before printing. If it isn't, the print routine is bypassed. If a field total is required, it is done in line 3130.

EPROM PROGRAMMER — Model EP-2A-79



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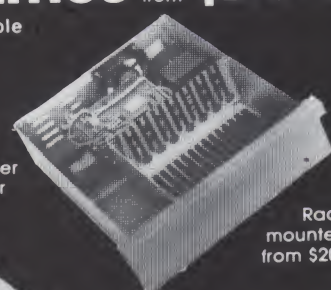

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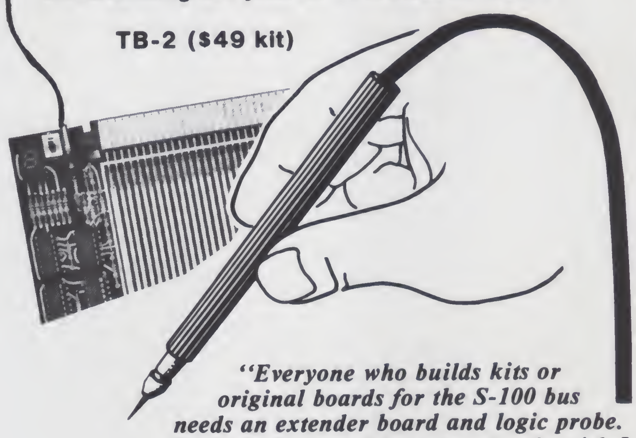

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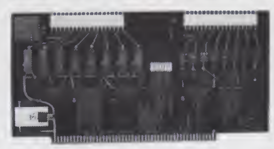

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```
836 G$=LEFT$(G$(R1),X-1):G$(R1)=RIGHT$(G$(R1),J-X)
838 RETURN
840!   PARSE G$ (TITLE, FIELD, CODE)
844 X=0:Y$(I)=RIGHT$(G$,2):G$=LEFT$(G$,LEN(G$)-2)
846 X=INDEX(G$,B$(1)):X$(I)=LEFT$(G$,X-1)
848 Z$(I)=MID$(G$,X+1,LEN(G$)-X)
849 RETURN
850!   LOAD X&Y ARRAYS WITH FIELD DATA
851 Y(1)=2:IFVAL(F$(2))<2THENRETURN
852 FORI=2TOVAL(F$(2)):Y(I)=Y(I-1)+VAL(Z$(I-1)):NEXTI
854 FORI=1TOVAL(F$(2)):X(I)=VAL(Z$(I)):NEXTI:RETURN
900!   COMPOSES DATE STRING (G$(2)))
901 X=3:FORK=1TOLEN(G$(2)):A$=MID$(G$(2),K,1):IFASC(A$)<48ORASC(A$)>57THEN904
902 B$=B$+A$
903 NEXTK
904 G$(X)=B$:X=X+1:B$="":IFK<LEN(G$(2))THEN903
905 IFLEN(G$(5))>2THENG$(5)=RIGHT$(G$(5),2)
906 FORJ=3TO5:IFLEN(G$(J))<2THENG$(J)="0"+G$(J)
907 NEXTJ:G$(2)=G$(3)+B$(7)+G$(4)+B$(7)+G$(5):RETURN
924 FORI=1TO5:G$(I)="":NEXTI:RETURN
990 INPUT"( Y OR N )";A$:IFA$<>"Y"ANDA$<>"N"THEN990
991 RETURN
995 PRINTREPEAT$(CHAR$(13),25):RETURN
997 PRINT:INPUT"PRESS RETURN TO CONTINUE";A:RETURN
998 PRINTREPEAT$(CHAR$(13),9):RETURN
999 PRINTREPEAT$(CHAR$(13),7):RETURN
1000!   READS PARAMETER DATA AND SETS ARRAYS
1001 GOSUB302:GOSUB500:OPEN1N$ERROR1002:ATTRS(1)=3:GOTO1003
1002 GOSUB612:GOTO1001
1003 GOSUB1110:GOSUB302:GOSUB1030:GOSUB302:GOSUB850:RETURN
1030!   DISPLAY FILE HEADING
1032 PRINT"HEADING DATA FOR FILE - ";RIGHT$(N$,LEN(N$)-2):PRINT
1034 PRINT"CODE = ";F$(1):PRINT"NUMBER OF FIELDS = ";F$(2):PRINT"SPECIAL FILENAME = ";F$(7)
1036 PRINT"DATE CREATED = ";F$(6):PRINT"LAST UPDATE = ";F$(8):PRINT:IFG$(5)=""ORG$(5)="0"THEN1038
1037 PRINT"RECORD #5 MESSAGE":PRINTG$(5)
1038 IFVAL(F$(3))>1THENPRINTF$(3);" RECORDS CODED FOR DELETION"
1039 PRINT"DATA RECORDS IN FILE";SIZE(1)-5:PRINT"RECORDS REMAINING ON DISK ";T*16:PRINT:GOSUB997:RETURN
1050!   DISPLAY DATA (G$(1))
1052 FORI=1TOVAL(F$(2))
1054 G$(2)="":G$(2)=MID$(G$(1),Y(I),X(I))
1055 PRINTI;TAB(5)X$(I);TAB(25)G$(2)
1056 IFI=15ORI=2*15THENGOSUB997
1058 NEXTI:RETURN
1060!   PULLS OUT SPECIFIC FIELD FOR SEARCH
1061 G$(2)="":G$(2)=MID$(G$(1),Y(A),X(A)):RETURN
1100!   READ RECORDS 1-5 FROM FILE
1101 FORI=1TO5:GET1RECORDIG$(I):NEXTI:RETURN
1110!   READ G$(1-5)FROM FILE:LOAD ARRAYS
1112 GOSUB1100:GOSUB607:R1=1:FORI=1TO30:GOSUB834:F$(I)=G$:NEXTI
1114 R1=2:FORI=1TOVAL(F$(2)):GOSUB830:GOSUB840:NEXTI
1119 RETURN
1350 IFA$="Y"THENC$="2"
1351 IFA$="N"THENC$="1"
1352 D$=D$+C$:C$="":RETURN
1400!   SETS UP TABS IN D% ARRAY
1405 FORI1=1TO31:D%(I1)=999:NEXTI1
1410 T1=1:T2=0:FORI1=1TOX3:IFT1+X(I1+1)>X1THENT2=T2+5:T1=T2
1412 D%(I1)=T1:T3=0
1413 T3=MAX(X(C%(I1)),LEN(X$(C%(I1)))):T3=MAX(T3,LEN(C$(C%(I1))))
1414 T1=T1+T3+2
1416 NEXTI1:RETURN
1500 GOSUB302:A=1
1510 GOSUB1000:GOSUB924:IFLEN(F$(4))<=1THEN1540
1520 PRINT"DO YOU WISH TO USE FORMAT FEATURE AS"
1530 PRINT"IN PREVIOUS REPORT FOR THIS FILE":GOSUB990:IFA$="Y"THEN1800
1540 GOSUB302:PRINT"ALL FIELD TITLES WILL BE DISPLAYED":PRINT"SELECT FIELDS YOU WISH PRINTED IN THE"
1550 PRINT"ORDER YOU DESIRE. ENTER \ WHEN DONE":PRINT:PRINT"ENTER 'ALL' IF ALL FIELDS ARE TO BE":PRINT"PRINTED IN FILE ORDER"
1560 PRINT:PRINT"ENTER 'T' DIRECTLY AFTER FIELD NUMBER":PRINT"IF YOU WANT TOTAL FOR FIELD"
1570 GOSUB997:GOSUB302:GOSUB1050:GOSUB997
1580 GOSUB302:D$="":V$="":FORK=1TOVAL(F$(2)):PRINT"COLUMN";K;:INPUT"-FIELD #";C$
1590 IFK=1ANDC$="ALL"THEND$=C$:GOTO1670
1600 IFC$=B$(1)THEN1670
1610 IFRIGHT$(C$,1)<>"T"THEN1650
1620 U$=RIGHT$(C$,1):C$=LEFT$(C$,LEN(C$)-1)
1630 IFLEFT$(Y$(VAL(C$)),1)<>B$(2)ANDLEFT$(Y$(VAL(C$)),1)<>B$(3)THEN1650
1640 U$=CHAR$(60+VAL(C$)):V$=V$+U$:U$=""
1650 C$=CHAR$(60+VAL(C$)):D$=D$+C$:C$=""
1660 NEXTK
1670 F$(9)="0":IFV$<>""THENF$(9)=V$
1680 F$(4)=D$:GOSUB302:PRINT"OTHER OPTIONS-ENTER DATA AS REQUESTED":GOSUB997
1690 C$="":D$="":GOSUB614:PRINT"DOUBLE SPACED LINES":GOSUB990:GOSUB1350
1700 GOSUB614:PRINT"STANDARD LINE LENGTH(132 CHARACTERS)":GOSUB990:GOSUB1350
1710 GOSUB614:PRINT"PAGES NUMBERED":GOSUB990:GOSUB1350
1720 GOSUB614:PRINT"REPORT DATED":GOSUB990:GOSUB1350
1730 GOSUB614:PRINT"FILENAME PRINTED":GOSUB990:GOSUB1350
1740 GOSUB614:PRINT"SPECIAL FILENAME OR PURPOSE PRINTED":GOSUB990:GOSUB1350
1750 GOSUB614:PRINT"NUMBER OF ENTRIES PRINTED":GOSUB990:GOSUB1350
1760 GOSUB614:PRINT"FILE CREATE DATE PRINTED":GOSUB990:GOSUB1350
1770 GOSUB614:PRINT"LAST FILE UPDATE PRINTED":GOSUB990:GOSUB1350
1780 GOSUB614:PRINT"FILE CODE PRINTED":GOSUB990:GOSUB1350
1790 F$(5)=D$:GOTO1800
```

Name reversals are controlled from line 3140, and formatting of dollar fields is done in line 3160.

Other printing is done in line *3170*. Line 3180 controls the wraparound feature from the data supplied by the tab setting routine in REPORT.

The heading subroutine in lines 3290–3460 creates a heading from the options determined in REPORT and is repeated at the beginning of each new page. Line 3470 has a PAGESIZE statement that takes care of this. The ENDPAGE statement is, in effect, a GOSUB to the heading for the start of a new page. Lines 3480–3520 take care of printing the totals at the end of the report.

When the report is complete, the operator is given the opportunity to record the format in the file itself. This is done in line 3270, after which the REPORT program is reloaded.

As I said before, RECOVERY (Listing 4) is a program that resulted from need (or desperation)—not too pretty but it works. Essentially, it is just stepping the end of file marker from a starting point, as determined by the operator, allowing the operator to read the data string in the file. Once the true end of file is determined, the marker is reset. As Murphy is always with us, it may be of some help.

Conclusion

I hope that this data base management system will give you both the flexibility and control of your data, used for both business and personal requirements. Certainly that is the objective. My application programs, some of which have been modified and some still to go, will be of more value to me with a standardized data system. I'm sure you will find this to be the case with your programs.

If you don't want to bother with the entry of the program, send $20 postpaid for a disk with all of the programs (and any updates). The disk will be formatted to Micropolis version 4.0 and can be obtained by sending a check or money order for that amount to:

Bonjoel Enterprises
PO Box 2180
Des Plaines IL 60018.■

```
1800!
1810 FORI=1TOLEN(F$(9)):E%(I)=ASC(MID$(F$(9),I,1))-60:NEXTI:X5=I
1820 FORI=1TOLEN(F$(5)):B%(I)=VAL(MID$(F$(5),I,1)):NEXTI
1830 IFF$(4)="ALL"ORLEFT$(F$(4),1)=B$(9)THENFORI=1TOVAL(F$(2)):C%(I)=I:NEXTI:X3=I:F$(4)=REPEAT$(B$(9),VAL(F$(2))):GOTO1850
1840 FORI=1TOLEN(F$(4)):C%(I)=ASC(MID$(F$(4),I,1))-60:NEXTI:X3=I
1850 FORI=1TOLEN(F$(4)):IFLEFT$(Y$(C%(I)),1)<>B$(2)THEN1900
1860 C$(C%(I))="V.99":K=0:P$=REPEAT$(CHAR$(32),X(C%(I))+5)
1870 IFK=3ANDLEN(C$(C%(I)))<LEN(P$)-2THENC$(C%(I))=","+C$(C%(I)):K=0
1880 IFLEN(C$(C%(I)))<LEN(P$)-1THENC$(C%(I))="Z"+C$(C%(I)):K=K+1:GOTO1870
1890 C$(C%(I))="$"+C$(C%(I)):P$=""
1900 NEXTI
1910 IFB%(2)=2THENX1=132:GOTO1940
1920 X1=132:GOSUB302:PRINT"NORMAL LINE LENGTH IS 132 CHARACTERS":PRINT"DO YOU WANT TO CHANGE"
1930 GOSUB990:IFA$="Y"THENINPUT"NEW LINE LENGTH";X1
1940 FORI=1TOX3:IFLEFT$(X$(C%(I)),4)=B$(14)THEN1960
1950 NEXTI:GOTO1970
1960 X2=1:GOSUB302:PRINT"YOU HAVE A 'NAME' FIELD IN FILE":PRINT"DO YOU WANT TO PRINT FIRST NAME FIRST":GOSUB990:IFA$="Y"THENX2=2
1970 O$="":GOSUB302:PRINT"ENTER TITLE FOR REPORT IF YOU WISH":PRINT"(50 CHARACTERS MAX.)"
1980 PRINT"OTHERWISE JUST TYPE RETURN":INPUTO$:IFLEN(O$)>50THENGOSUB603:GOTO1970
1990 GOSUB1400:IFB%(4)=2THENGOSUB302:PRINT"ENTER DATE FOR REPORT":INPUTG$(2):GOSUB900:H$=G$(2)
2000 X4=0:GOSUB302:PRINT"YOU MAY ELECT TO PRINT YOUR REPORT":PRINT"WITHIN MINIMUM AND MAXIMUM LIMITS OF"
2010 PRINT"A SELECTED FIELD. DO YOU WISH TO USE":PRINT"THIS OPTION":GOSUB990:IFA$="N"THEN2100
2020 GOSUB1050:PRINT"SELECT FIELD FOR WHICH YOU WISH TO":PRINT"SET LIMITS":INPUTX4
2030 GOSUB302:PRINT"ENTER DATA FOR LOWER LIMIT OR \ IF YOU":PRINT"WISH TO DISREGARD LOWER LIMIT":INPUTL$:GOSUB2040:PRINT:PRINT
2035 PRINT"ENTER DATA FOR UPPER LIMIT OR \ IF YOU":PRINT"WISH TO DISREGARD UPPER LIMIT":INPUTU$:GOSUB2060:GOTO2100
2040 IFL$=B$(1)THENL$="":GOTO2050
2045 IFLEFT$(X$(X4),4)=B$(13)THENG$(2)=L$:G$(3)="":G$(4)="":G$(5)="":GOSUB900:L$=G$(2):RETURN
2046 IFLEFT$(Y$(X4),1)=B$(3)THENL$=REPEAT$(CHAR$(32),X(X4)-LEN(L$))+L$:RETURN
2050 IFLEN(L$)<X(X4)THENL$=L$+REPEAT$(CHAR$(32),X(X4)-LEN(L$))
2055 RETURN
2060 IFU$=B$(1)THENU$=REPEAT$(CHAR$(255),X(X4)):GOTO2070
2065 IFLEFT$(X$(X4),4)=B$(13)THENG$(2)=U$:G$(3)="":G$(4)="":G$(5)="":GOSUB900:U$=G$(2):RETURN
2066 IFLEFT$(Y$(X4),1)=B$(3)THENU$=REPEAT$(CHAR$(32),X(X4)-LEN(U$))+U$:RETURN
2070 IFLEN(U$)<X(X4)THENU$=U$+REPEAT$(CHAR$(32),X(X4)-LEN(U$))
2075 RETURN
2100!
2110 CHAIN"PRINTER"
2500 GOTO100
3000 GOTO100
5000 GOTO100
9950 PLOADG"DATABASE"
```

Listing 3. PRINTER.

```
10!    REPORT GENERATOR-PRINT PROGRAM
20!      BY JOEL SHAPIRO 6/79
30!
40!          FILENAME-PRINTER
50!
80!
100 DIMA%(25),E(30):GOTO3000
302 POKE(16R6B8)=65:D=FAA:POKE(16R6B8)=41:D=FAA:RETURN
500!
520 FORN9=0TO1:A$=MID$(STR$(N9),2,1):OPENAA$+":"+N$ ERROR540
530 N$=A$+":"+N$:T=FREETR(A):CLOSEA:RETURN
540 IFERR=4ORERR=7THENNEXTN9
550 GOSUB995:PRINTERR$:PRINT"STOPPED":PRINT"MAKE CORRECTION":GOSUB999:GOSUB997:GOTO520
560 GOTO520
570 GET2G$(1):I=1:K=1:A$="":IFG$(1)=""THEN3240
571 B$=MID$(G$(1),K,1):IFB$<>B$(1)THENA$=A$+B$:K=K+1:GOTO571
572 A%(I)=VAL(A$):A$="":K=K+1:IFI=25THENRETURN
573 IFK<LEN(G$(1))THENI=I+1:GOTO571
574 RETURN
810!    BUILD G$(1)
812 FORI=1TO30:G$(1)=G$(1)+F$(I)+Y$:NEXTI:RETURN
924 FORI=1TO5:G$(I)="":NEXTI:RETURN
990 INPUT"( Y OR N )";A$:IFA$<>"Y"ANDA$<>"N"THEN990
991 RETURN
995 PRINTREPEAT$(CHAR$(13),25):RETURN
997 PRINT:INPUT"PRESS RETURN TO CONTINUE";A:RETURN
999 PRINTREPEAT$(CHAR$(13),7):RETURN
1061 G$(2)="":G$(2)=MID$(G$(1),Y(A),X(A)):RETURN
1420!    REVERSES NAME (FIRST NAME FIRST)
1421 FORI5=LEN(G$(2))TO1STEP-1:IFMID$(G$(2),I5,1)=CHAR$(32)THENNEXTI5
1422 G$(2)=LEFT$(G$(2),I5+1)
1427 G$(3)="":E=INDEX(G$(2),B$(6)):IFE=0THENRETURN
1428 G$(3)=LEFT$(G$(2),E-1)
1429 G$(2)=RIGHT$(G$(2),LEN(G$(2))-(E+1))+G$(3):RETURN
3000!    PRINTER S/R
3010 GOSUB302:PRINT"DO YOU WISH TO USE AN INDEX FILE":GOSUB990:M$=N$
3020 X8=0:A=2:IFA$="Y"THENX8=1:GOSUB3230:PRINT"ENTER NAME OF INDEX FILE":INPUTN$:GOSUB520:OPEN2N$END3240:ATTRS(2)=3
3030 GOSUB302:OPEN1M$END3240:ATTRS(1)=3:M$=RIGHT$(M$,LEN(M$)-2)
3040 GOSUB302:PRINT"SET UP PRINTER":GOSUB997:K2=0:GOSUB3470
3050 GOSUB924:GOSUB3310:GETSEEK(1)=6
3060 IFX8=1THENGOSUB570:N=I:FORK1=1TON:IFA%(K1)<=5THEN3210
3070 IFX8=1THENGET1RECORDA%(K1)G$(1):GOTO3090
3080 GET1G$(1)
```


✓ Reader Service—see page 227

```
3090 IFLEFT$(G$(1),1)=B$(9)THEN3210
3100 IFX4=0THEN3130
3110 A=X4:GOSUB1061:IFG$(2)>=L$ANDG$(2)<=U$THEN3130
3120 GOTO3210
3130 FORI=1TOX3:A=C%(I):GOSUB1061:FORI3=1TOX5:IFE%(I3)=ATHENE(A)=E(A)+VAL(G$(2))
3140 NEXTI3:IFX2=2ANDLEFT$(X$(C%(I)),4)=B$(14)THENGOSUB1420:GOTO3170
3150 IFLEFT$(Y$(C%(I)),1)<>B$(2)THEN3170
3160 PUT3TAB(D%(I))FMT(VAL(G$(2)),C$(C%(I)));:GOTO3180
3170 PUT3TAB(D%(I))G$(2);
3180 IFD%(I)>D%(I+1)THENPUT3
3190 NEXTI:IFB%(1)=2THENPUT3
3200 PUT3
3210 IFX8=1THENNEXTK1:GOTO3060
3220 GOTO3080
3230 PRINT:PRINT"PLACE DISK WITH INDEX FILE INTO DRIVE":GOSUB997:RETURN
3240 IFASC(LEFT$(F$(9),1))<>48THENGOSUB3480
3250 ENDPAGE3:PUT3:PUT3:PUT3:CLOSE3:IFX8=1THENCLOSE2
3260 GOSUB302:PRINT"REPORT COMPLETE":PRINT:PRINT"DO YOU WISH TO RECORD OPTIONS IN USE":PRINT"FOR FUTURE REPORTS":GOSUB990
3270 IFA$="Y"THENG$(1)="":ATTRS(1)=0:GOSUB810:PUT1RECORD1G$(1):ATTRS(1)=3
3280 CLOSE1:PLOADG"REPORT":!   END
3290!   HEADING S/R
3300 PUT3:PUT3:PUT3:CLOSE3:GOSUB3470
3310 PUT3:PUT3:PUT3
3320 K2=K2+1:IFB%(4)=2THENPUT3H$;"      ";
3330 IFLEN(O$)>1THENPUT3O$;
3340 IFB%(3)=2THENPUT3TAB(X1-10)"PAGE";K2;
3350 PUT3
3360 IFB%(5)=2THENPUT3"FILE ";M$;"      ";
3370 IFB%(6)=2THENPUT3F$(7);"      ";
3380 IFB%(10)=2THENPUT3"FILE CODE ";F$(1);
3390 PUT3
3400 IFB%(8)=2THENPUT3"FILE CREATED ";F$(6);"      ";
3410 IFB%(9)=2THENPUT3"FILE UPDATED ";F$(8);"      ";
3420 IFB%(7)=2THENPUT3(SIZE(1)-5)-VAL(F$(3));"ENTRIES";
3430 PUT3:PUT3
3440 FORI1=1TOX3:PUT3TAB(D%(I1))X$(C%(I1));
3450 IFI1<X3ANDD%(I1)>D%(I1+1)THENPUT3
3460 NEXTI1:PUT3:PUT3:RETURN
3470 OPEN3"*P"PAGESIZE63ENDPAGE3290:RETURN
3480 PUT3:PUT3:D$="$ZZZ,ZZZ,ZZZV.99":FORI=1TOX5
3490 PUT3"TOTAL ";X$(E%(I));" = ";
3500 IFLEFT$(Y$(E%(I)),1)=B$(2)THENPUT3FMT(E(E%(I)),D$):GOTO3520
3510 PUT3 E(E%(I))
3520 NEXTI:RETURN
```

Listing 4. RECOVERY.

```
10!   DISK FILE RECOVERY PROGRAM
20!      BY JOEL SHAPIRO 6/79
30!
40!        FILENAME-RECOVERY
50!
60 SIZES(5,3,250)
70 STRINGCHAR$(255)
80 GOSUB510:GOTO1000
510 GOSUB995:PRINT"ENTER NAME OF FILE"
512 PRINT"OR \ TO EXIT PROGRAM"
515 GOSUB999:INPUTN$:IFN$="\"THEN1130
520 FORN9=0TO1:A$=MID$(STR$(N9),2,1):OPEN1A$+":"+N$ ERROR540
530 N$=A$+":"+N$:T=FREETR(1):CLOSE1:RETURN
540 IFERR=4ORERR=7THENNEXTN9
550 GOSUB995:PRINTERR$:PRINT"STOPPED":PRINT"MAKE CORRECTION":GOSUB999:GOSUB997
560 GOTO510
990 INPUT"( Y OR N )";A$:IFA$<>"Y"ANDA$<>"N"THEN990
991 RETURN
995 PRINTREPEAT$(CHAR$(13),25):RETURN
997 PRINT:INPUT"PRESS RETURN TO CONTINUE";A:RETURN
998 PRINTREPEAT$(CHAR$(13),9):RETURN
999 PRINTREPEAT$(CHAR$(13),7):RETURN
1000 OPEN1N$:S=SIZE(1)
1010 GOSUB995:PRINT"END OF FILE MARKER IS AT RECORD #";S:PRINT
1020 PRINT"ENTER STARTING RECORD NUMBER FOR":PRINT"SEARCH FOR TRUE END OF FILE":INPUTK
1030 IFK<1THENGOSUB998:PRINT"ILLEGAL RECORD NUMBER":GOSUB999:GOSUB997:GOTO1020
1040 K=K+1:GOSUB995:EOF(1)=K:GET1RECORDK-1G$
1050 PRINTG$
1060 PRINT"DOES THIS RECORD SEEM TO BE CORRECT":GOSUB990
1070 IFA$="Y"THEN1040
1080 PRINT:PRINT"DO YOU WISH TO SET THE END OF FILE":PRINT"MARKER AT THIS PLACE":GOSUB990
1090 IFA$="Y"THENEOF(1)=K-1:CLOSE1:GOTO1110
1100 GOTO1020
1110 GOSUB995:PRINT"END OF FILE MARKER HAS BEEN SET":PRINT
1120 PRINT"ANY MORE FILES TO WORK ON":GOSUB990:IFA$="Y"THEN80
1130 PLOADG"DATABASE"
```

Reader Service—see page 227

I made the TRS-80* into a serious computer. Now I've made the Model II into a spectacular one.

I'm Irwin Taranto, and I've helped almost a thousand businesses get their first computers up and running.

I've done it primarily with the TRS-80, because it's a really elegant piece of hardware. Given the right programs, it can do substantially the same work as the traditional minicomputers that cost four times as much.

I proved it with four on-line, interactive programs adapted from the genuine Osborne & Associates systems, originally designed for the $30,000 Wang computer. Then I added two of my own and made them all work on a $4000 TRS-80.

Now I've done the same thing for the new TRS-80 Model II. It's an $8000 computer that works twice as fast and has four times the memory—up to two million characters.

My new systems are fully documented, and because I'm working with a much more powerful computer, they're a night-and-day advance over the Model I programs. They'll turn your Model II into a complete business computer, set up and ready to go.

THE TRS-80 MODEL II PROGRAMS

General Ledger/Cash Journal: handles up to 7000 transactions on 500 different user-defined accounts. It keeps track of them by month, quarter and year, makes comparisons to the prior year, and does departmentalization.

Accounts Payable/Purchase Order: generates the purchase order and posts the item to payables when the goods are received. Invoice-linked, it calculates and prints checks and aged ledger reports and links fully to the general ledger.

Accounts Receivable/Invoicing: keeps track of billed and unbilled invoices, open and closed items, aging and service charge calculation. It prints statements, links to the general ledger, and can work within either an invoice-linked or balance-forward accounting system.

Payroll/Job Costing: computes regular, overtime and piecework pay, keeps employee files, figures taxes and deductions, prints checks, journal, 941-A and W-2 forms, and breaks out individual job costs.

*A trademark of the Tandy Corporation.

When I say set up and ready to go, I mean just that. If you're not quite sure on that point, call the number below and we'll give you the names of some of the people who've already bought all over the world. Call them up and hear what they have to say.

These Model II programs are completely custom-tailored, which explains their $249.95 price. Before we'll send you a disk, you have to fill out a detailed questionnaire that tells us your precise business requirements. Then we send you the disk, all the instructions you need, and my phone number. If you call, we answer all your questions. *If your questions are tough enough, I'll talk to you personally.*

Because that way I'll make sure that Model II of yours turns into a spectacular computer, just like I promised.

☐ Please send me the custom questionnaires for the following $249.95 Model II programs:

- ☐ General Ledger/Cash Journal
- ☐ Accounts Payable/Purchase Order
- ☐ Accounts Receivable/Invoicing
- ☐ Payroll/Job Costing

☐ Please send me information on the TRS-80 Model I programs at $99.95 each

☐ Please send me information on other Taranto business programs

Your name ____________________

Company name ____________________

Address ____________________

City/State/Zip ____________________

✓T57

Taranto
& ASSOCIATES, INC.

P.O. Box 6073, 4136 Redwood Hwy., San Rafael CA 94903 • (415) 472-2670

Stand-alone Video Terminal

This terminal uses a large-scale integration CRT controller from American Microsystems.

Bonaventura Paturzo
1929 Trudie Drive
San Pedro CA 90732

A new breed of LSI chips—the CRT controllers—has emerged, promising to lighten the design load not only for people in industry, but also for the hobbyist, especially as prices plummet into the practical range of the home experimenter. Several manufacturers—including Intel, Motorola and Standard Microsystems—now offer these devices. This article does not intend to provide an overview of all these devices. We will only be concerned with their use in the design of a stand-alone video terminal.

Introduction

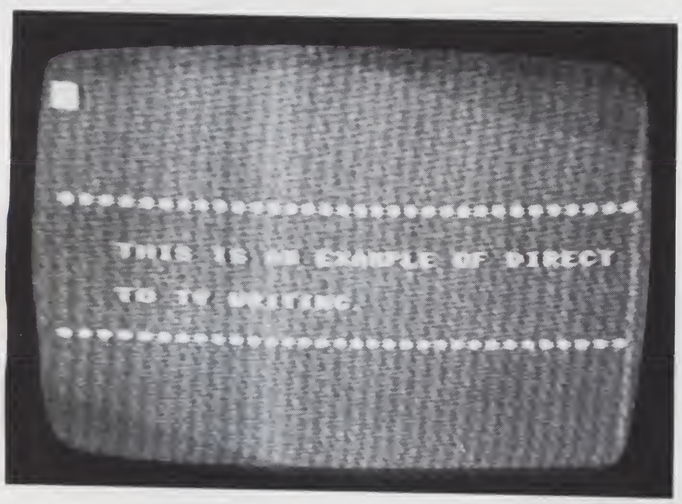
Together with an ASCII-encoded keyboard and either a monitor or, with the addition of an rf modulator, an ordinary television set, the circuit provides for a two-way (send/receive) communication with any computer that has provision for a serial input/output. Many computers have this feature, usually specified as RS-232 or 20 mA current loop (for Teletypes).

The design is stand-alone in the sense that it doesn't rely on the microcomputer it is connected to for updating and refreshing of the characters (information) being displayed. The terminal features the following:

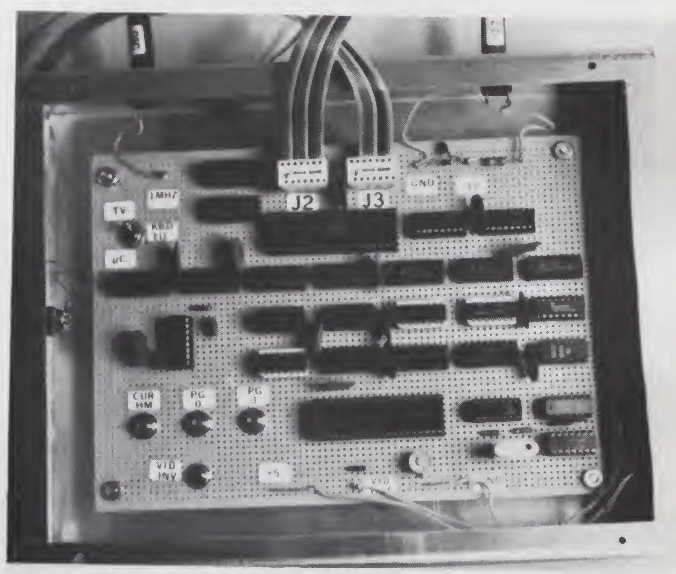
Two pages of 16 lines, with 32 characters per line
Carriage return decoding
"White box" cursor
Cursor home
Page zero/page 1 select
Screen clear
Video invert (white on black or black on white)
Direct-to-TV writing provision

All of the above features have been implemented in hardware so no software is needed to operate the unit—this ultimately relieves the microprocessor of these tasks. The direct-to-TV writing ability illustrates the terminal's independence from the host microcomputer.

This design was originally for my SYM-1 microcomputer board when I found out that it wasn't practical for me to spend two to four times the board's price for a new (or used) Teletype or for one of the so-called "dumb" CRT terminals. That left me with the



The TV screen says it all in this picture.



Finished terminal on a 6×8 inch perfboard mounted in an 8×10 inch chassis box. Note that there was enough room to mount most of the switches on the perfboard. J2 goes to my keyboard, while J3 goes to the SYM-1. Next to "VID OUT" is C3, which adjusts the line width. I recommend using labels for all devices and terminals.

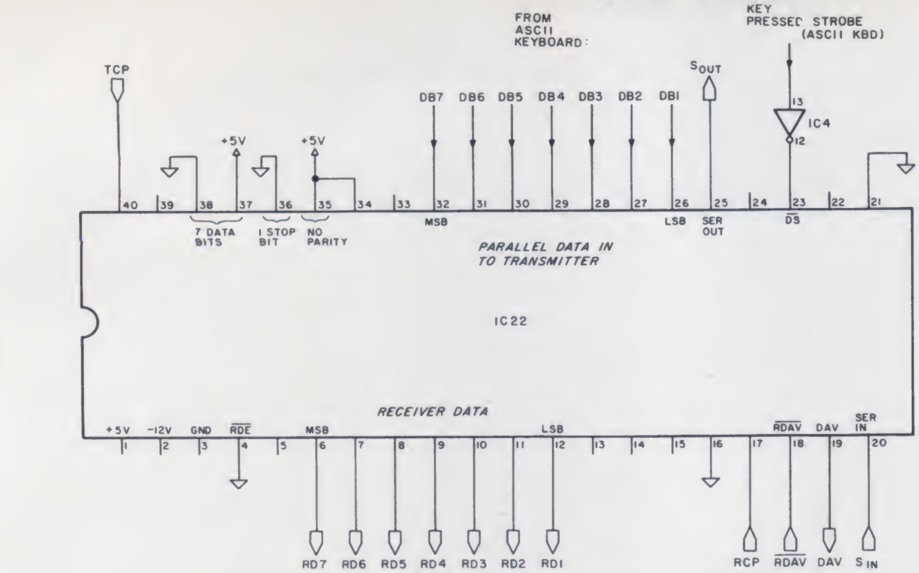


Fig. 1. IC22.

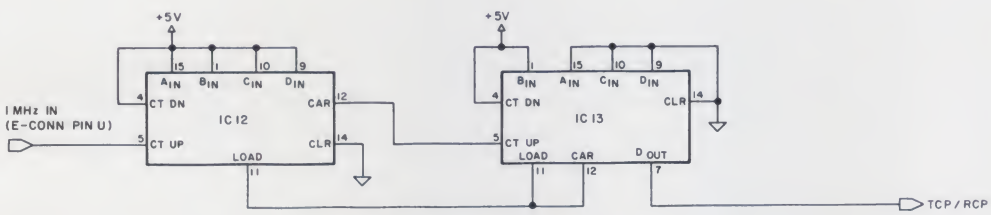


Fig. 2. 300-baud clock circuit.

video interface boards offered by quite a few manufacturers. Most of the boards were S-100 based. I found some video boards that were stand-alone or designed for the KIM-based bus, but at that point I was confident enough to try my hand at a home design. Besides, it was less expensive, and the challenge it presented seemed surmountable.

So, armed with Don Lancaster's book, *TV Typewriter Cookbook,* plus numerous articles from *Kilobaud* and *Byte*, I set to work. I am tempted to call the result TVT-3 R2 (for revision 2) or Bugs-Out 12, because of all the changes made in the original design. As for that surmountable challenge mentioned before, imagine trying to climb a mountain that turned out to be gelatin. However, I recommend that anyone interested in the hardware aspects of microcomputers try his or her hand at a similar design task.

System Components

The LSI CRT controller—called the S68047—is a unit made by American Microsystems, Inc. They call it a video display generator (VDG), and, actually, the abilities of this device go much further than the "TV Teletype" requirements detailed here. In fact, anyone interested in color graphics generation should investigate this device since it has the ability to produce up to eight colors. If you're interested, write AMI (3800 Homestead Rd., Santa Clara CA 95051) for their spec sheet, IEEE article reprint and their application note. (See *Microcomputing*, Feb. 1980, p. 148.)

The VDG has a fixed matrix of 16 lines of 32 characters when in its alphanumeric mode. It has an on-chip 64 ASCII-character generator (in a 5 × 7 dot matrix font) and all the high-frequency timing circuits to squirt out the characters to your monitor (or rf modulator/TV), including the synchronization signals to keep everything on your screen stable. I used an ex-TV game rf modulator and one of the world's cheapest tube-type black and white sets (its insides are done in early transistor radio), with quite legible results.

The UART (IC22, Fig. 1) provides the parallel-to-serial (and

IC1,IC25	7408 TTL
IC2,IC7	7400 TTL
IC3	7432 TTL
IC4	7404 TTL
IC5	74123TTL
IC6	7474 TTL
IC8,9,12,13	74193 TTL
IC10	74LS125 TTL
IC11	74LS367 TTL
IC14-20	2102L-4 MOS
IC21	S68047 (AMI)
IC22	UART: AY-5-1013A (G.I.)
IC23,24	7485 TTL
IC26	7486 TTL
S1,S2,S3	SPDT (Momentary) Switches
S4	SPDT (ON/ON) Switch
S5	DPDT (ON/ON) Switch
S6	DPDT (Momentary) Switch
R1,R2	10k 5% ¼W
R3,R4	470Ω 5% ¼W
R5	3k 5% ¼W
C1,C2	0.001uF 20% 25v
C3	Variable Capacitor—15-60pF
MISC.	3.5795 MHz Xtal, rf Modulator, 1 MHz Osc., Perf-board, etc.

Power Supply Connections

IC1,2,3,4,6,7,10,25,26	: 14 = +5	; 7 = GND
IC5,8,9,11,12,13,23,24	: 16 = +5	; 8 = GND

All other chips have specified P.S. pins in the figures.

Parts list.

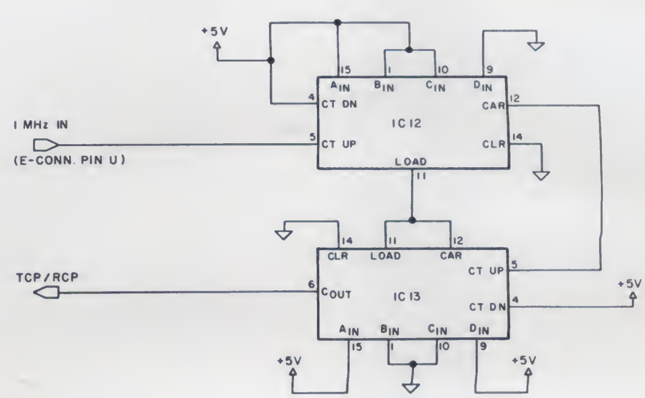


Fig. 3. 600-baud clock circuit.

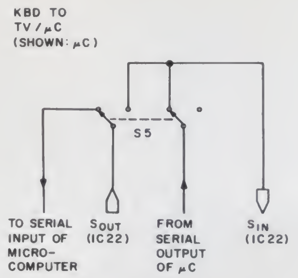


Fig. 4. Switch S5 wiring.

vice versa) interface. The parallel input is from your ASCII keyboard; this is serialized and sent to the microcomputer. Usually, the microcomputer (if it has a serial interface) has an "echo" feature, in that the data you just sent it comes back from its "serial out" port. This goes to the UART's serial input, is changed to parallel form and displayed on the screen. In the same way, any data sent by the microcomputer is output through its serial out port to the UART . . . you know the rest.

The clock going to the UART is shown in Fig. 2. You will note that it needs a 1 MHz input, which naturally the SYM-1 provides on its expansion connector, pin U. I hope your microcomputer has a 1 MHz clock or something dividable to 1 MHz. The circuit shown in Fig. 2 is for operation at 300 baud; for 600 baud, use the circuit in Fig. 3. I don't recommend using anything faster than 600 baud.

Words of Warning

If your keyboard has a negative-going "key-pressed" strobe, delete the inverter going to IC22's pin 23; otherwise, keep it in. Also, determine what type (TTL level, RS-232, 20 mA current loop) of serial interface you do have. Then, if you have a SYM-1 (VIM-1) you'll be able to use TTL logic levels; however, the serial out (pin 25 on IC22) must be inverted before it is sent to the SYM-1's RS-232 input. Also, the SYM-1's RS-232 output must be inverted before going to the UART's serial input (pin 20, IC22).

If you have a microcomputer that uses TTL levels, you should be able to use the existing design; if you have an RS-232 serial interface that actually uses RS-232 logic levels (bipolar), then you'll need a TTL-to-RS-232 interface between IC22, pin 25, and your microcomputer's serial input, and an RS-232-to-TTL interface between your microcomputer's serial output and pin 20 of IC22. Similarly, for the 20 mA interface you'll need a TTL to 20 mA loop interface and a 20 mA loop to TTL interface.

Electronic Systems (Dept. B, PO Box 21638, San Jose CA 95151) provides interface boards for the above at a modest price; for additional information, check Don Lancaster's *TV Typewriter Cookbook*. Note that whatever serial interface you do use, Fig. 4's wiring still holds. That is, Sout and Sin are wired *directly* to IC22's

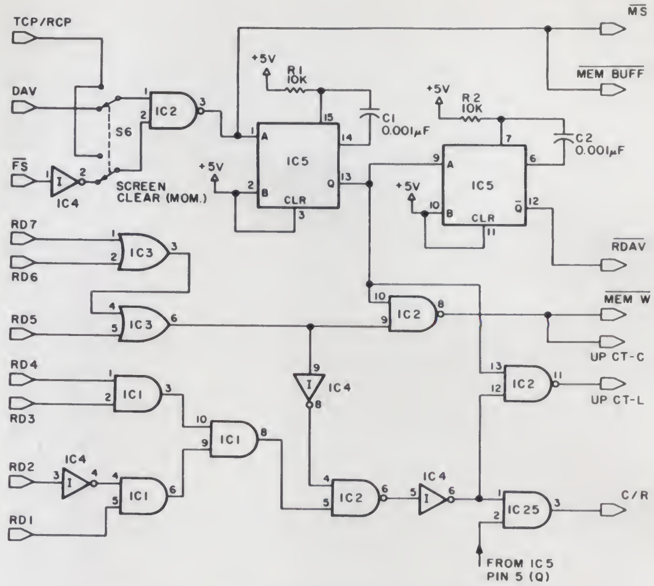


Fig. 5. Interfacing address and select lines.

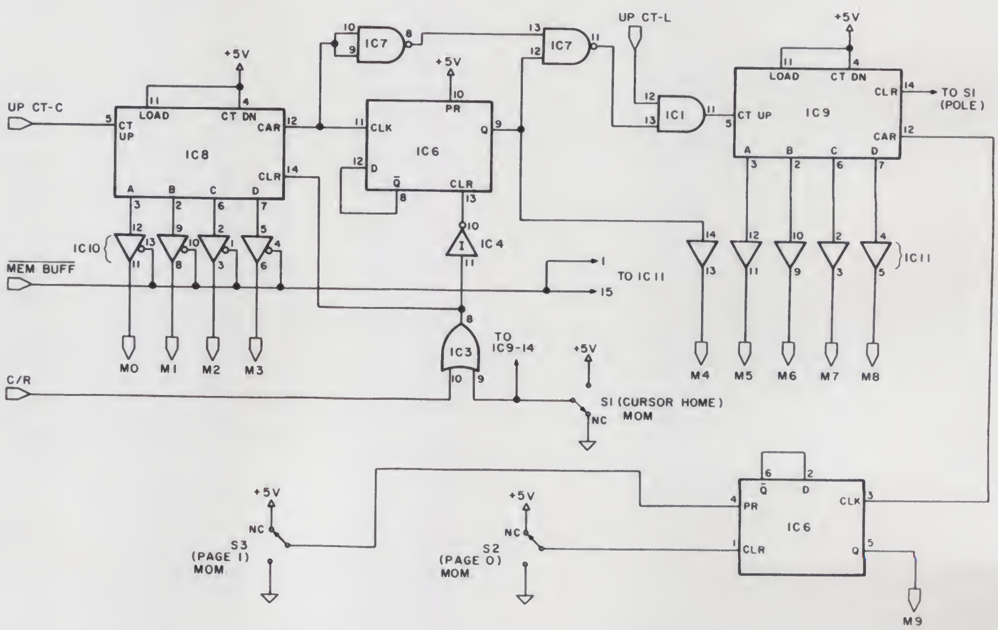


Fig. 6. Interfacing address and select lines.

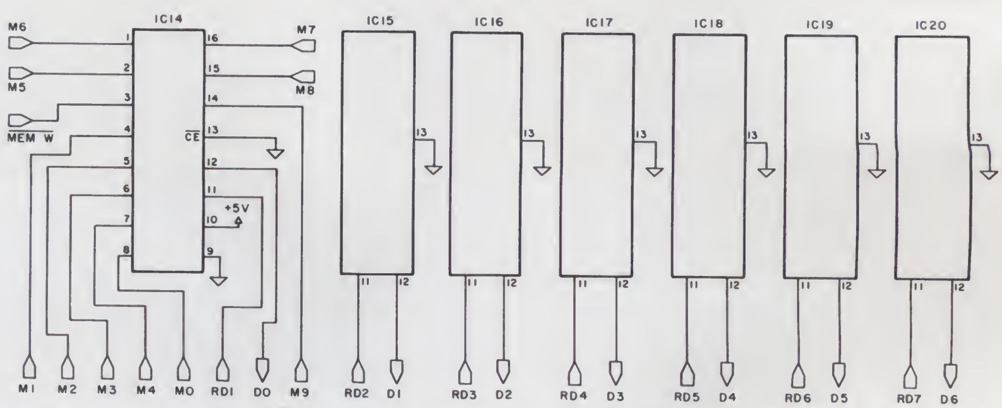


Fig. 7. Memory address select M0–M9 are tied to all seven memory chips as is the memory Read/$\overline{\text{Write}}$ command ($\overline{\text{MEM W}}$). All chip enable ($\overline{\text{CE}}$) pins must be tied to ground.

pin 25 and pin 20, respectively. The remaining two connections of switch S5 in Fig. 4 are then wired to the serial interface (TTL-to-RS-232, etc.) used or directly to the microcomputer's serial ports.

Operation

Figs. 5 and 6 show the decoding circuitry, character and line counters and the Tri-state buffers needed to interface the refresh memory's (IC14-20, Fig. 7) address lines to the VDG's memory address select lines (M0-M8) and the character and line counters' memory address select lines (M0-M8). The page select line M9 (Fig. 6) goes directly to the refresh memory's "high" address pin.

When the UART (IC22) signals that it has data ready for display, its DAV pin goes high; IC2 (Fig. 5) waits until the TV or video monitor is in vertical retrace, that is, the $\overline{FS}$ pin of the VDG goes low, before triggering IC5 for a write to refresh memory operation. If the data from the UART (RD1-RD7) indicates it is a carriage return, it will not be written into the refresh memory.

After the data are written into the refresh memory, pin 8 of IC2 clocks IC8 (up CT-C) to increment it to the next character location. If the data on RD1-RD7 has been a CARRIAGE RETURN code, IC25's pin 3 would have gone high, clearing the character counter (IC8 and half of IC6), and IC2, pin 11, would have clocked the line counter IC9 up to the next line.

Regardless of the type of data, after the circuit has digested it the other half of IC5 goes low ($\overline{RDAV}$) and resets the UART's data available pin. When the VDG is displaying the contents of the refresh or video memory, buffers IC10 and IC11 are placed in their "disconnected" state so that the VDG can sequentially address the refresh memory. The VDG has internal Tri-state buffers going to the refresh memory's address pins—these buffers are "Tri-stated" when data is to be written into memory (DAV high) and the TV/monitor is in vertical retrace ($\overline{FS}$ low) through IC2's

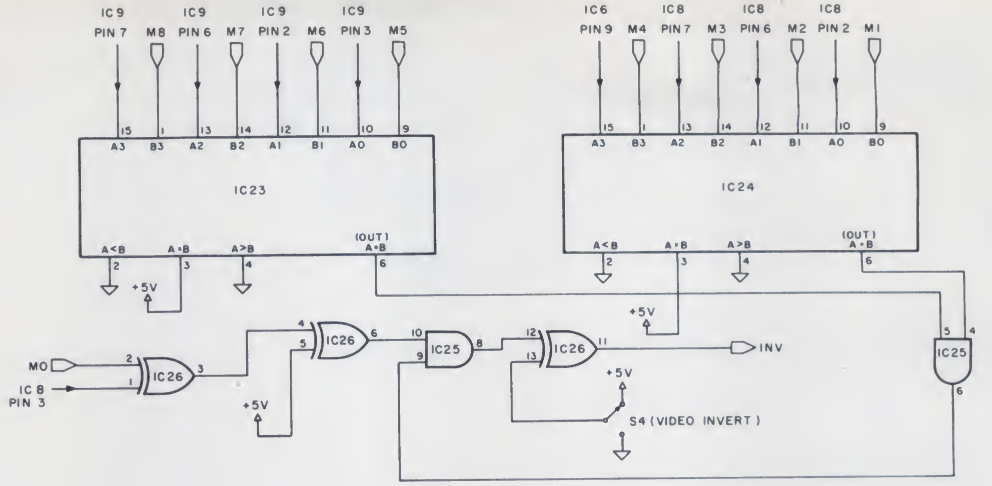


Fig. 8. ICs 23-26.

pin 3 labeled "$\overline{MS}$".

As shown in Fig. 8, IC23 and IC24 (together with IC25 and IC26) compare the character/line counters' current address selection with the VDG's sequentially changing address selection and generate a pulse when the counters and VDG agree. This pulse goes to the VDG's video invert pin and is used to create the box cursor, since the character line counters are in the memory address location where the next data are to be written.

Fig. 4 shows the direct-to-TV feature—the UART's output becomes its input, so whatever you type on your keyboard is written into the refresh memory. Fig. 9 shows the color clock needed by the VDG to develop most of its internal and external (horizontal and vertical sync) timing.

Conclusion

Switch S6 is a momentary DPDT, and when the screen is to be erased (both pages will be cleared), you must hit the space bar *then* push S6. Thus the UART's output (seen on RD1-RD7) will "hold" the code for a space so that when S6 is pressed the 16X clock going to the UART will also clock IC5 so that "spaces" are written into all locations of the refresh memory. Since this 16X clock is relatively fast, a quick push on S6 does the trick.

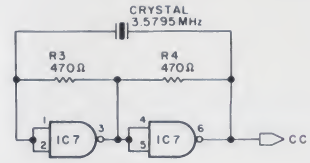


Fig. 9. VDG color clock.

Other than that serial interface, you shouldn't have any difficulty with this circuit. I built mine on perfboard, which had enough room for most of the switches. If you plan to modify this circuit, I suggest you also wire-wrap it. I purchased the S68047 from Intermark Electronics (1802 E. Carnegie Ave., Santa Ana CA 92705); it arrived after about 1 week. ■

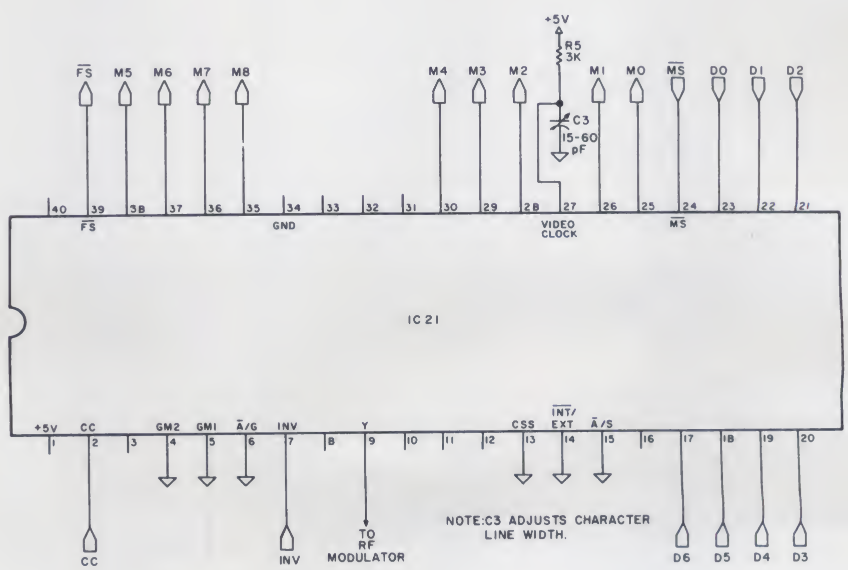


Fig. 10. IC21.

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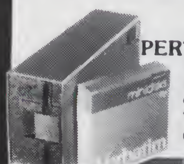

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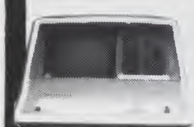

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Little Bits

Rod Hallen
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Read a Parallel Port

This routine reads a parallel port in line 50 (port 24 in my case) and then prints messages (lines 60 to 140) depending upon which of the data lines in that port are active. Lines 30 and 170 turn my printer on and off, and line 150 slows down the loop so that it is read approximately once each minute. The actual loop time will depend on how many print statements are required. "I," therefore, is only a rough indication of when an event occurred.

For example, data line zero (DO0) could be tied through a contact closure in a garden humidity detector to +5 V dc. (See Fig. 1.) When the humidity level dropped below a given point, the contact would close and a statement such as "180 The grass needs water." would be printed. This would indicate that the contact closed approximately 180 minutes after the program was started.

This routine could also read your sense switches to provide external control to programs that were in progress. It was written in Processor Technology's Extended BASIC. ■

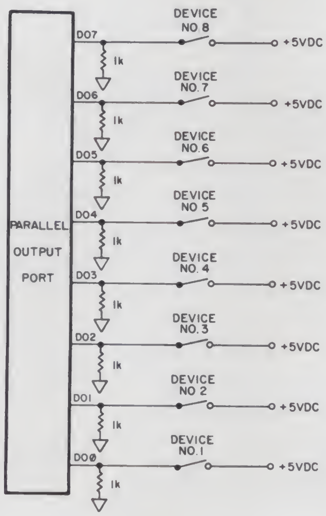

Fig. 1.

```
10 REM-ROUTINE TO READ POSITIVE CLOSURES TO A PARALLEL PORT
20 REM-ROD HALLEN TOMBSTONE, AZ 21 JUNE 1978
30 SET OP=1
40 FOR I=0 TO 1440
50   LET X=INP(24)
60   IF X=0 THEN  PRINT I,"ALL DEVICES INACTIVE": GOTO 150
70   IF X>127 THEN  PRINT I,"DEVICE #8 IS ACTIVE": LET X=X-128
80   IF X>63 THEN  PRINT I,"DEVICE #7 IS ACTIVE": LET X=X-64
90   IF X>31 THEN  PRINT I,"DEVICE #6 IS ACTIVE": LET X=X-32
100  IF X>15 THEN  PRINT I,"DEVICE #5 IS ACTIVE": LET X=X-16
110  IF X>7 THEN  PRINT I,"DEVICE #4 IS ACTIVE": LET X=X-8
120  IF X>3 THEN  PRINT I,"DEVICE #3 IS ACTIVE": LET X=X-4
130  IF X>1 THEN  PRINT I,"DEVICE #2 IS ACTIVE": LET X=X-2
140  IF X=1 THEN  PRINT I,"DEVICE #1 IS ACTIVE"
150  PAUSE 590
160  PRINT
170 NEXT I
180 SET OP=0
190 END
```

Program listing.

James Garon
920 West Romneya, #6
Anaheim Ca 92801

Screen Printer for TRS-80

As you may know, Radio Shack has two printers—a screen-printer, which makes a copy of the screen when a button is pressed, and a line-printer, which is controlled by Level II software. I have a Centronics Microprinter P-1, which costs less than either of the above, and plugs directly into the TRS-80 expansion box.

My only complaint had been that when I wanted a copy of whatever was on the screen, the line-printer was helpless! So I wrote the accompanying subroutine to do the job. ■

```
LIST
10 CLS:PRINT@340,"# 1"
20 PRINT"A NEW LINE PRINTER - SHINY & CLEAN
30 PRINT"WHEN ENHANCED WITH A BRIEF SUBROUTINE
40 PRINT"            CAN MAKE UP FOR THE LACK
50 PRINT"            OF A RADIO-SHACK
60 PRINT"PRINTER FOR PRINTING THE SCREEN
70 GOSUB9000
80 CLS
90 PRINT@340,"# 2
100 PRINT"SO IF YOU HAVE THE LINE PRINTER BLUES,
110 PRINT"MY FRIEND, I WAS ONCE IN YOUR SHOES
120 PRINT"            JUST TAKE MY ADVICE -
130 PRINT"            THE RESULTS WILL BE NICE
140 PRINT"AND WHAT'S MORE, YOU HAVE NOTHING TO LOSE"
150 GOSUB9000
160 CLS:END
9000 V=15360 : REM  ADDRESS OF UPPER LEFT CORNER OF SCREEN
9010 FOR R = 0 TO 15
9020 FORC=0 TO 63
9030 LPRINT CHR$( PEEK ( V + 64*R +C ) ); : REM  NOTE SEMICOLON!
9040 NEXT C
9050 LPRINT" "
9060 NEXT R
9070 RETURN

                     # 1
        A NEW LINE PRINTER - SHINY & CLEAN
        WHEN ENHANCED WITH A BRIEF SUBROUTINE
                CAN MAKE UP FOR THE LACK
                OF A RADIO-SHACK
        PRINTER FOR PRINTING THE SCREEN
```

Program listing.

Ray Tully
Boyce Thompson Institute
for Plant Research
Cornell University
Ithaca NY 14853

Unambiguous Hex Display

Anyone using a seven-segment LED to display hexadecimal knows that the 6 and the lowercase b are easily confused. My Elf II microcomputer, which uses 9368 hex decoders/drivers to operate the LEDs, is a typical example.

One way to clear the ambiguity is to use the method delineated by Dave Maciorowski ("Displaying Hexadecimal," *Kilobaud*, April 1978, p. 104), in which a decimal point is used with the b, but not the 6. This method requires the use of a PROM. There is, however, a simple modification of a 9368 circuit that will produce the same effect and can easily be added to an existing circuit.

The idea is to decode the segment-driver outputs of the 9368 to turn on the decimal point during b display. An examination of an LED's segment assignment (Fig. 1) shows that when b is displayed, segments *a* and *b* are kept low, and that this is the only character for which this is true.

In order to decode this to the high necessary to drive the decimal point, the *a* and *b* outputs of the 9368 (or actual segment pins of the display) are connected to a 7402 NOR gate (Fig. 2). When a b is displayed, the two inputs are pulled low by the 1k resistors, giving a high output that drives the decimal point LED. With any other character, one or both lines are high, giving a low output and extinguishing the LED.

To add the circuit to my Elf microcomputer, I epoxy-cemented the 7402 against the underside of the board and soldered the resistors and wires directly to the pins. Because there were two digits, two of the 7402's gates were used. I also used this method of hex display when I constructed the address display circuit described by Robert Cotter in the December 1978 *Kilobaud* ("Interfacing the Elf II," p. 40). With both devices, there is now no question as to which character is 6 and which is b. ■

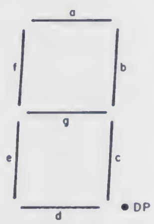

Fig. 1. Segment assignments of display LED. Segments a *and* b *are extinguished during lowercase b display, while* a *is on during 6 display.*

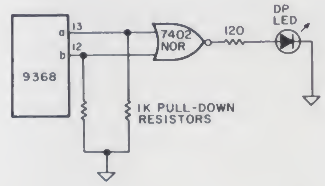

Fig. 2. Circuit configuration for decimal point with b.

Charlie Heath
110 Cherokee Circle
Chapel Hill NC 27514

Z-80 Dynamic Memory Refresh

I am developing a Z-80 CPU card as a radio-telescope controller but have plans to put it to my personal use in its spare time. Here is an idea that can reduce power-supply requirements for dynamic memory utilizing the Z-80's internal refresh.

My memory chips are 2107B-4s, which require 2 ms refresh cycles on A_0-A_5. The Z-80 supplies the required cycles but does it more often than is necessary, thus drawing more power. This circuit (see Fig. 1) reduces power requirements for refresh by nearly a factor of 4 by eliminating three out of four refresh cycles.

The circuit still requires a high peak power since all dynamic memories are simultaneously refreshed. To solve this problem, you can bring 0_C and 0_D onto spare S-100 bus pins and decode them into four states, alternating refresh cycles to different RAM boards (see Fig. 2).

A note of caution: With any Z-80 refresh, beware of DMA operations longer than 1 ms, which will wipe out your dynamic memory! ■

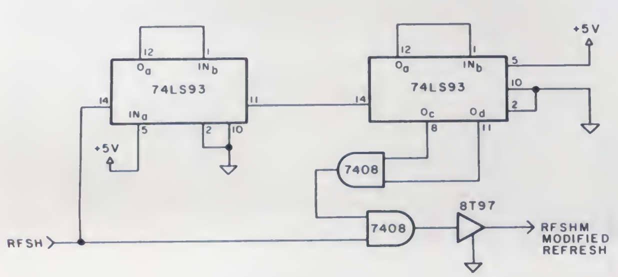

Fig. 1.

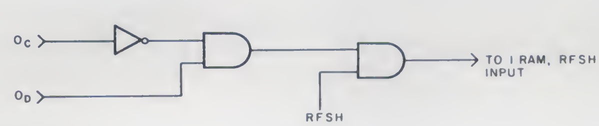

Fig. 2.

D. C. Shoemaker
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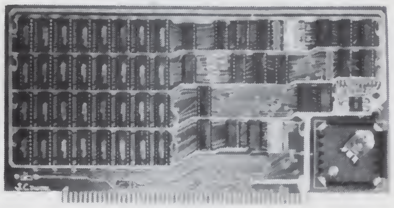
Speed up Loading BASIC on Heath's H8/H17

If you have a Heath H8 with an H17 floppy-disk drive (or two) and you have sufficient memory that you normally load the HDOS Operating System's overlay (using the CNTRL 4,1 command from the terminal), then you are doubtlessly aware that you must do that operation manually. It cannot be embedded in a BASIC program without causing an error when that program is loaded.

Relax, there's a simple way around the problem. Recall that you can freeze BASIC (and whatever file you're working on) and store it all in absolute form (.ABS extension). Just load BASIC, type CNTRL 4,1, freeze BASIC and rename the BASIC.BAF as BASIC.ABS (first deleting the original BASIC.ABS). You now have a BASIC interpreter with the overlay "built in," and it even takes one sector less!

Load time is down to about two seconds on my particular system (partly due to writing the BASIC file first so it's "all together" instead of forcing the drive to "hunt" through several sectors scattered all over the disk). This was first pointed out to me by Dave Cobets, manager of Heath's retail store in Kansas City. ■

16K STATIC RAM



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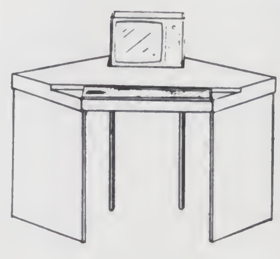

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Thoughts on the SWTP Computer System

Installment number 10 checks out the chips in SWTP's 64K dynamic RAM board.

Did you know that SWTP has been making a 64K dynamic RAM board for almost two years? I have been using that board—with just 48K of chips—in my system for the last few weeks, and it works great. I had to move all of my I/O out of the 8000 address range, but now I have memory from 0000 all the way to BFFF—on one board!

The SWTP 32K Dynamic Memory Board

In the first installment of this series (March 1979), I mentioned my quest to find out what ICs this board used. This 32K board is available from SWTP in two versions. The older versions used thirty-two 8K × 1 RAMs, while the newer board uses sixteen 16K × 1 RAM chips. All the memory chips are made by Motorola. You may remember that Motorola doesn't make any 8K × 1 dynamic RAMs. However, the 16K dynamic RAM is the same 4116 IC that is used in the TRS-80, Apple II and many other systems. It is now made by some IC manufacturers under different numbers; the same RAM is numbered a 2116, 416, 4116 or 6116, depending on who

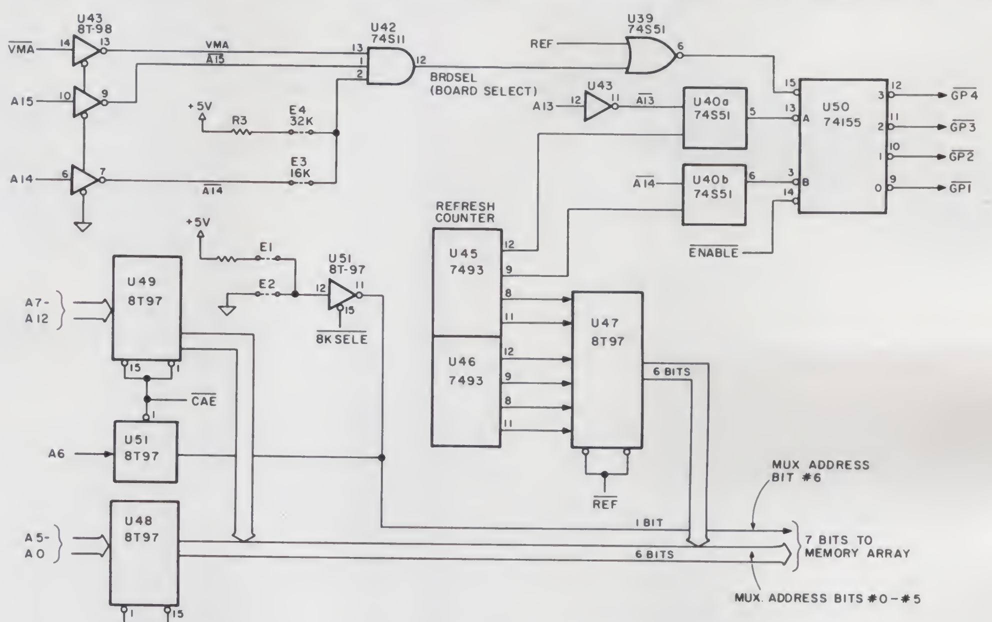


Fig 1. Block diagram of SWTP 32K dynamic RAM board.

is the manufacturer.

When the 4116 was first produced, it was expensive. The IC manufacturers had a lot of trouble making it and had to throw away much of the production lot because only a small percentage of the ICs worked.

The 4116 memory IC was built with the memory array split into two parts and with some of the support circuitry in the middle of the chip. Often a defect in the chip—most often produced by a small pinhole in the negative used to make it or a fault in processing—would disable half of the memory array but leave the other half and the support circuitry working. This 16K RAM then only had 8K of good memory.

Since the 4116 was so expensive, several manufacturers decided to use these "8K" RAMs rather than throw them out. This led to, among other boards, the SWTP 32K dynamic RAM board. It had 32 of these "bad" memory chips and was made for SWTP

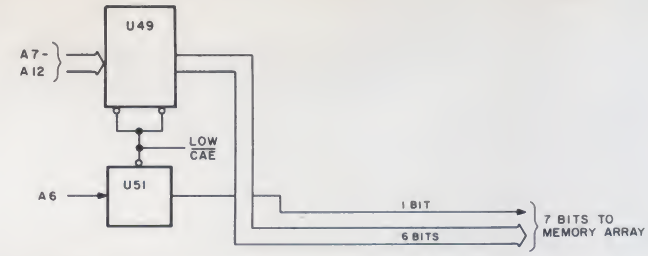


Fig. 2. Address path during Column Address Enable.

by Motorola.

As production facilities improved, the yield increased and the proportion of 8K ICs dropped, so at some point Motorola redesigned the board to use only 16 "good" memory chips. That's the current board.

The old board with 32 ICs (let's call it the 32-IC board) was available with only 16K of memory installed (only 16 ICs) at $400, and an expansion kit of 16 more ICs to expand it to 32K was available from SWTP for another $250. The new board with 16 "good" ICs (let's call it the 16-IC board) is apparently only available in the full 32K version at $650.

If you have the new 16-IC board, you might as well stop reading right here. The rest of this article applies to the old 32-IC board. Sorry.

If you have the old 32K board, which has 32 "bad" ICs, what do you think will happen if you replace the "bad" ICs with "good" ones? Absolutely right! You'll have a 64K board! (Don't rush off yet. You have to make some other changes too.)

It makes sense. If you replace the thirty-two 8K × 1 RAMs with thirty-two 16K × 1 RAMs, you will double the storage capacity of the board to 64K bytes.

There are other variations. You can replace the 32 "bad" ICs with 16 "good" ones and keep the board at 32K but cut the current consumption in half.

Another alternative for those who have a partially populated 32K board with only 16K of memory installed is to expand to 32K by adding just eight more ICs, instead of 16.

I chose a third way. By using 16 "bad" chips and 16 "good" ones, I have a 48K board.

The idea of expanding a 16K board to 32K by adding only eight ICs occurred to me when I wrote the first installment of this series, but at that time I already had my board at 32K and didn't yet have a diagram of the board. I quickly forgot the idea until I had a discussion with a friend who had an unexpanded 32K board.

After making the old 32-IC memory board for awhile, Motorola's IC production improved enough that the 8K × 1 "bad" ICs became scarce. At this point Motorola redesigned the board, but it seemed there was a point where the old board was supplied with at least some "good" ICs. So you may have a 48K or 64K board now and not know it.

That was the case with my board. The original board came with 16K of ICs, and all of these were "bad" by virtue of having just 8K locations. The add-on kit I bought to expand the board to 32K had all "good" ICs, so I was able to expand my board from 32K to 48K at almost no cost.

SWTP 32K Board Operation

Fig. 1 is a simplified block diagram of the 32K board, showing only those parts of the board that concern addressing. Let's see how it works.

A 16K × 1 IC chip requires 14 address bits, since $2^{14} = 16384$. But the 4116-type chips have a multiplexed address that uses only seven address pins. Since the 4116 was designed for dense packing on printed circuit boards, this approach kept the IC in a small 16-pin package, rather than a larger 24-pin package. Thus, a 14-bit address must be combined externally onto a 7-bit bus and fed into the 4116 memory ICs in two chunks. As you can see in the lower-left corner of Fig. 1, a whole batch of address bits is combined in several 8T97 ICs onto seven address lines. I show them separately in Fig. 1 as six bits and a separate single bit, since they are treated differently.

Since the memory bits inside the 4116 RAMs are physically stored in an array of 128 rows and 128 columns, seven of the address bits are used to select one of the 128 rows, while the other seven select one of the 128 columns. The two timing signals that control the multiplexing of these two address parts onto the same seven memory IC pins are called $\overline{\text{CAE}}$, $\overline{\text{Column Address Enable}}$, and $\overline{\text{RAE}}$, $\overline{\text{Row Address Enable}}$.

In normal operation, the CPU puts a 16-bit address, consisting of bits A0 through A15, on the address bus. Of these 16 bits, 14 (A0 through A13) are separated into row and column addresses. When the low $\overline{\text{CAE}}$ signal comes, bits 6 through 12 are gated through ICs U49 and U51 to the memory; this is the column address circuitry shown in Fig. 2.

A fraction of a microsecond later, the $\overline{\text{RAE}}$ signal arrives and lets bits A0 through A5 go through U48 to become the row address (see Fig. 3). It looks as though the bits get scrambled on their way to the memory chips, but this doesn't matter. If a number is stored in a "wrong" location, it will later be read back from the same "wrong" location, so the order of address bits doesn't matter as long as the same order is used during reading as during writing.

The 4116 ICs require 14 address inputs, but only 13 are actually supplied from the address bus because the ICs hold 16K. This requires 14 address bits (since 2^{14} is 16K), while this board uses them only as 8K memories (and 2^{13} is 8K).

Although only 13 bits are available, the ICs still require 14 bits, even if they are defective. So an extra 14th dummy bit is generated on board, using one of two jumpers: jumper E1, if used, will always make that bit a 1; while jumper E2, if used, will always make it a 0. This bit is fed through another part of U51, gated by a signal called $\overline{\text{8KSELE}}$, and becomes the seventh bit of the row address. $\overline{\text{8KSELE}}$ is a signal that goes on (low) most of the time $\overline{\text{CAE}}$ is not on. This is also shown in Fig. 3.

Why two jumpers, and how are they chosen? I mentioned earlier that the 8K chips are really defective 16K chips. Only half —either the upper 8K or lower 8K—is good. These chips are sorted out by Motorola, which makes sure that all the chips on a given board have the same half good. The extra bit generated by the jumper determines which half of each chip is actually used on that board. On my board, jumper E1 was in and made that extra bit a 1 . . . upper half good.

If your board had chips with a good lower half, then jumper E1 would be missing, and jumper E2 would make that extra bit a 0. By looking at E1 and E2, you can tell which half of your memory ICs is good.

When I bought my board with just 16K installed, jumper E1 was installed. When I got the 16K add-on kit, nobody asked me which jumper I had! I reasoned that all the add-on ICs had to be good. That way, regardless of where the jumper was, the additional *ICs would*

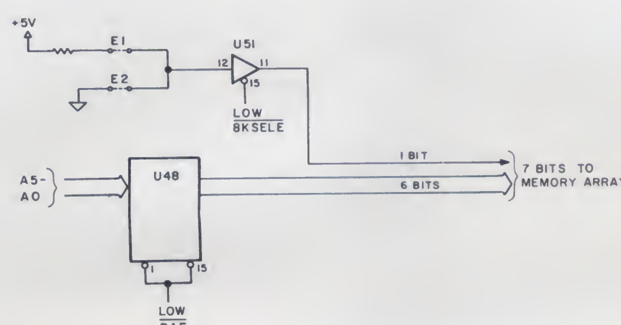


Fig. 3. Address path during Row Address Enable.

still be using a good half. (There was a period when the 16K add-on was installed at the factory and you had to send the board back for a retrofit if you wanted to change from 16K to 32K. It is possible that these added chips were bad ones.)

To tell whether you have good or bad chips on your board, simply move the jumper, wherever it is, to the other position and run a memory test. If all of your 32K tests OK, all your chips are good. If 16K tests OK while the other 16K makes errors, you have some good and some bad ICs. If all of it fails the memory test, then all the ICs are bad (i.e., only half bad).

Continue to look at Fig. 1. Dynamic memory ICs must be refreshed at periodic intervals. The 4116 needs refreshing at least once every two milliseconds by addressing each row of the IC, one at a time. A program that was active enough to race all through memory fast enough to touch each row at least once every two milliseconds would require no additional refreshing. In general, though, our programs can't be guaranteed to do that, so special refreshing circuitry is needed.

The SWTP board has two binary 7493 counters, U45 and U46, which continuously count up during operation. Six of their outputs are fed through U47, another 8T97, to six of the IC address lines. This path, shown in Fig. 4, is controlled by a $\overline{\text{REF}}$, Refresh, signal, which is present during phase 1 of the clock when the board is not being used for reading or writing. Thus, refreshing is squeezed between actual reading and writing of memory data.

Now note that the refresh address from the refresh counter only consists of six bits; the seventh bit comes from jumper E1 or E2 via U51 and is always either 0 or 1. Thus, on this 32K board, only one half of each IC is really refreshed. The "bad," or unused, half is not. This has to be changed to extend the board past 32K.

Continue through Fig. 1. In the upper left of the diagram is the board selection circuitry, which generates a board select signal called BRDSEL. This circuit starts with three inverters, which invert VMA (valid memory address) and address bits A15 and A14. Going through another set of jumpers, they go to an AND gate in U42, which generates the BRDSEL signal.

Fig. 5 shows what the jumper does. When in the 16K position (see Fig. 5a), BRDSEL is generated only when VMA is high and $\overline{\text{A15}}$ and $\overline{\text{A14}}$ are both high; this requires that A15 and A14 both be low, which means that only addresses starting with 00 bits will generate BRDSEL. This covers hex addresses from \$0000 up to \$3FFF, or the first 16K.

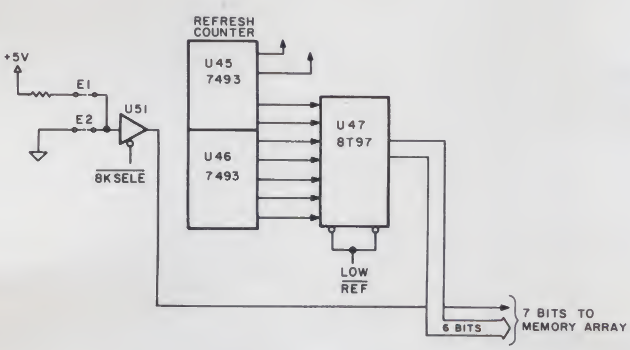
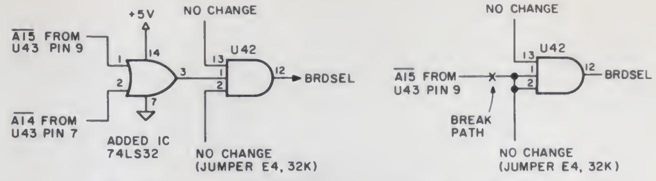


Fig. 4. Address path during refreshing.

(A) 16K BOARD *(B) 32K BOARD*

Fig. 5. BRDSEL Board Select logic for 16K and 32K.



(A) 48K MODIFICATION *(B) 64K MODIFICATION*

Fig. 7. BRDSEL modification.

With the jumper in the 32K position, $\overline{\text{A14}}$ is taken out of the circuit, to give the result of Fig. 5b. Now bit A14 is no longer important, and only A15 has to be 0. This enables the board for all addresses starting with a 0 bit, or hex addresses \$0000 through \$7FFF. Extending this board past 32K means modifying this circuit too.

Finally, look at the top right corner of Fig. 1. This circuitry generates four signals, which SWTP calls $\overline{\text{RAS}}$1, $\overline{\text{RAS}}$2, $\overline{\text{RAS}}$3 and $\overline{\text{RAS}}$4. I think a better name would be $\overline{\text{GP}}$1 through $\overline{\text{GP}}$4, for $\overline{\text{Group}}$ 1 through $\overline{\text{Group}}$ 4, since these signals select a group of eight ICs on the board. As Fig. 6 shows, the 32 memory ICs on the board are placed there in four vertical groups of eight. The $\overline{\text{GP}}$1 signal selects the eight ICs of Group 1, and so on. In this way, any memory read, write or refresh only affects one group of ICs at any given time.

When a board is used with just 16K of memory, 16 ICs are installed in Group 1 and 2 sockets; Group 3 and 4 sockets are empty. In this case, the board is disabled when A14 is high, so the $\overline{\text{A14}}$ input to U40B, which eventually winds up at U50 to generate the GP signals, does nothing. Only GP1 and GP2 signals are generated. In a 32K board, A14 is used, so the board generates all four GP signals. This is another circuit that may have to be changed if we modify the board for a nonstandard memory configuration.

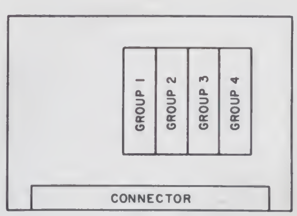


Fig. 6. IC placement on the board.

Modifications

Up until now, we have just looked at how this board works. From now on, I'll discuss how to change it. Do not make any changes to this board unless you fully understand what's involved and are thoroughly familiar with digital circuits and the operation of your system. I don't want to get a batch of broken memory boards in the mail to fix!

Once again, you are on your own. I do not guarantee any of the following modifications. I have only made the one modification to extend my board to 48K; all other changes described are based on an analysis of the circuit diagram furnished by SWTP, not on actual experience with this board.

BRDSEL modifications. The BRDSEL circuit is set up for either 16K or 32K addressing. If you are extending the board to 48K or 64K, see the mods shown in Fig. 7.

Break the path bringing $\overline{\text{A15}}$ from U43, pin 9, to U42, pin 1. For 48K, add a 74LS32 OR gate as shown, and for 64K just connect U42, pin 1, to pin 2. In both cases, use jumper E4, set for 32K operation.

In Fig. 7a, pin 1 of U42 will be high whenever either $\overline{\text{A15}}$ or $\overline{\text{A14}}$ is high, which means that either A14 or A15 must be a 0. This corresponds to all addresses from \$0000 through \$BFFF. Both of these address bits are 1 only for addresses above \$C000.

In Fig. 7b, $\overline{\text{A14}}$ and $\overline{\text{A15}}$ are both disconnected from U42, and pins 1 and 2 are both held high through jumper E4. Thus, the board will be selected all the time, regardless of the address.

GP (group) select modifications. Modifications to the GP

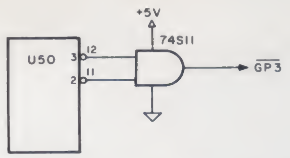


Fig. 8. Modifying the GP circuits for a 32K board using 24 ICs.

circuit are more complicated because they depend on exactly how you configure the board. Let's discuss a couple of possibilities.

1. 32K board using only 16 good ICs. Plug all the good ICs into Group 1 and 2 sockets, leave Group 3 and 4 sockets empty. Break the path from U40B, pin 6, to U50, pin 3, and ground pin 3. Doing this disables the $\overline{GP3}$ and $\overline{GP4}$ signals and selects Group 1 when A14 is a 0 and Group 2 when A14 is a 1.

2. 32K board using 16 bad ICs and eight good ICs. Plug the 16 bad ICs into Group 1 and 2 sockets, plug the eight good ICs into Group 3, then cut the paths to U50, pins 11 and 12, and insert an AND gate as shown in Fig. 8. Pins 11 and 12 formerly produced the $\overline{GP3}$ and $\overline{GP4}$ signals. Now whenever either of these signals is low, the AND gate will produce $\overline{GP3}$ and enable the good ICs plugged into the Group 3 sockets.

3. 48K board using 16 bad ICs and 16 good ICs. Plug the 16 good ICs into Group 1 and 2 and plug the 16 bad ICs into Group 3 and 4 sockets. Don't change any wiring in the Group selection circuitry.

4. 64K board using 32 good ICs. Plug the good ICs into all sockets and make no changes in the Group selection circuits.

Upper/lower half bit selection. Jumpers E1 and E2 select which half of the memory ICs you use. With a standard board, only the upper or lower half is used. For this reason, the jumper at the input to pin 12 of U51 normally always supplies either 0 or 1 as the selection bit. As soon as you start using some good memory ICs and want to use both the upper half as well as the lower half, you must remove this jumper and supply an address bit there instead. Again, there are many possibilities, depending on exactly what board configuration you use.

1. 32K board with 16 good ICs. Remove jumpers E1 and E2, and instead connect U51, pin 12, to U43, pin 7. This connects $\overline{A14}$ to this bit and uses one half of memory in the lower 16K (when A14 is 0) and the other half in the upper 16K (when A14 is 1).

2. 32K board with 16 bad ICs and eight good ICs. This modification is done in two ways, depending on whether your bad ICs have a good lower half or good upper half.

a. Good lower half (jumper E2 was originally installed). Remove both E1 and E2 and connect a NOR gate as shown in Fig. 9a. With this mod, if either A14 or A13 is 0, this extra address bit will be 0 and the lower half will be used. If both A14 and A13 are 1 (which includes addresses \$6000 through \$7FFF), then we will use the upper half of the good ICs.

b. Good upper half (jumper E1 was originally installed). Remove both E1 and E2 and connect an OR gate as shown in Fig. 9b. This does the opposite of the above and uses the upper half everywhere except between address \$6000 and \$7FFF.

3. 48K board with 16 good ICs and 16 bad ICs. This again depends on which half of the bad ICs is good.

a. Good lower half (jumper E2 originally installed). Remove both E1 and E2 and connect pin 12 of U51 to A15 at U43, pin 10. This selects the lower half of all ICs for the first 32K and then selects the upper half of the good ICs for the last 16K.

b. Good upper half (jumper E1 originally installed). Remove both E1 and E2 and connect pin 12 of U51 to $\overline{A15}$ at U43, pin 9. This does the exact opposite of the above.

4. 64K board using 32 good ICs. Remove both E1 and E2 and connect pin 12 of U51 to $\overline{A15}$ at U43, pin 9. This uses the upper half of all ICs for the first 32K and the lower half for the second 32K.

Another interesting possibility is to configure the 64K board as two 32K boards with bank switching under program control. If you remove both E1 and E2, and instead connect pin 12 of U51 to a PIA output pin, then you can switch from the lower 32K to the upper 32K under program control. This allows you to hold a different program in each 32K, and under program control switch from one to the other.

One use is time-sharing. One 32K "board" could hold a BASIC interpreter and user program; while the other could hold PILOT, for instance. A timer could generate interrupts at periodic intervals, and an interrupt service routine in high memory—an 8K board at address A000–BFFF, for instance—could switch from one to the other at every interrupt. This is similar to what SWTP does with their multi-user board, except they switch only the lower 4K of memory. By swapping an entire 32K block, we could switch not only users, but also languages. If this were done right, both users could access disk files or run programs without even being aware of each other's presence on the system.

Refresh circuit modifications. As I mentioned before, the original SWTP 32K circuit only refreshes the "good" half of memory. As soon as you expand the board in any configuration other than its standard one, you must change the refreshing circuitry.

Forgetting to do this gives some interesting effects. Although dynamic memory IC spec sheets specify refreshing every two milliseconds, in most cases the 4116 RAMs will remember data for a second or two. It's strange to use the M command of the monitor to load something into a location, see it there and a few seconds later find it's gone.

To make this modification, first disconnect the $\overline{8KSELE}$ signal from U51, pin 15, and connect pin 15 instead to $\overline{RAE}$ at U48, pin 1. Substituting $\overline{RAE}$ instead of $\overline{8KSELE}$ lets the seventh bit from U51 provide an actual memory address, *but disconnects it from the memory ICs during refresh.*

Then add the circuit of Fig. 10 to provide this bit during refreshing. This circuit adds a 7473 flip-flop to the refresh counter; this lengthens the refresh counter so it can provide a seven-bit row address. The 74367 (or equivalent) Tri-state buffer then connects that bit to the seventh memory address line during refreshing.

If you are using 16 good ICs to provide 32K of memory, then this circuit is simpler. As you can see in Fig. 1, breaking the path from U40B, pin 6, to U50, pin 3, takes U40B out of the circuit; in essence, this prevents one bit of the refresh counter (pin 9 of U45) from being used. This bit can now be used instead of having to add the 7473 flip-flop shown in Fig. 10. Simply omit this flip-flop and connect directly from U45, bit 9, to pin 2 of the 74367 (or equivalent) IC that you are adding.

How to Make These Changes

I have found several useful

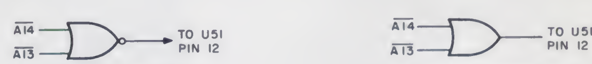


Fig. 9. Bit selection for 32K board with 24 ICs

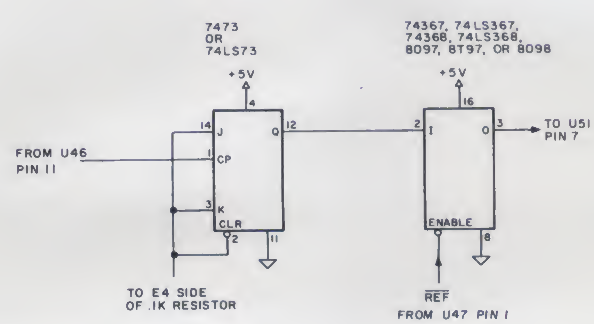


Fig. 10. Refresh counter addition

tricks in modifying this board. I cut a circuit trace in two spots, about 1/8 inch apart, by cutting through with a razor blade. Then, to make sure that the break is really there, I scrape off the disconnected piece of copper between the two cuts with the hot tip of a soldering iron. This leaves a clean break that is easy to see if you want to repair it at some later time.

There is a spare 16-pin IC position in the upper left corner of the board into which you can mount an extra new IC you may want. As to the others, I generally put a pot of hot-melt glue on the top of an IC and then tack it down, pins up, against the underside of the board. In this case, I tacked them down right under an existing IC, making sure to position them in the same direction as the ICs they were under. The 74367 (which is pin compatible with the 8T97 it was mounted under) had its pin 7 and pin 14 (ground and Vcc power) connected with short wire jumpers to the same pins of the IC just above. This procedure makes power connections a breeze.

For wiring, I use a combination of wire-wrapping and soldering. I use a hand wire-wrap tool and some pre-cut wrap-type wire (available in a combination package from O.K. Machine and Tool Corp., 3455 Conner St., Bronx NY 10475). I wind two or three turns of the wire around one of the IC pins with the tool, cut off the excess and then put a spot of solder on to hold it. I then tack-solder the other end of the wire to the appropriate spot on the board. This has worked out well in a lot of projects. (Although many people like the kind of wire whose insulation melts when you solder it, I feel that it takes too much heat to melt it . . . too dangerous to fragile boards and components.)

Now that we have examined the various ways to modify your 32K memory board you may wonder what you can do with it. Next month we will look at the many factors that determine its operation. ■

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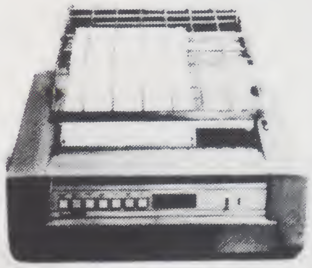

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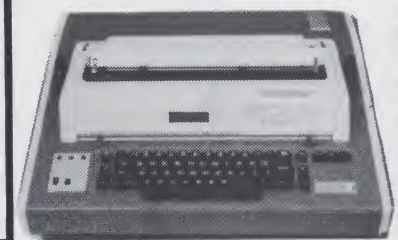

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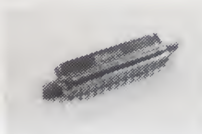

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✓ Reader Service—see page 227

Do the Job for a Lot Less

Use an Exidy word-processing system. (This one has a Comprint printer; see review, p. 56.)

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This article describes how we acquired, set up and put into operation an excellent word processor for a modest price: about $3000 plus the cost of a typewriter.

We are attorneys engaged in general practice in a small community south of San Francisco. There are two attorneys and one secretary. We turn out about 2000 letters a year and hundreds of pages of wills, leases and contracts.

Our biggest problem in document production is drafts. A seven- or eight-page will may go through two or three versions before the client approves it. Worse, a client may have given us erroneous information (such as misspelling an heir's name), and the majority of the will may have to be redone.

Certain agreement documents such as contracts and leases almost always require several versions before the parties are willing to sign them. We were increasingly tying up our secretary on retypings.

Over a year ago, we started looking for a word processor for our office. We discovered that the large companies wanted what seemed a fortune for an office system. We also discovered that earlier models of word processors were just starting to go on the used market for reasonable prices, but to our way of thinking, they were just typewriters anyway.

Another, essential, consideration was user control of the system and quality of the documents it was producing. We had to have a system that we could rely on to produce the same, error-free text on each occasion. The horror for any professional using a word processor is that a line may drop out somewhere or a word suddenly disappears, producing what is euphemistically referred to as a "scrivener's error," but what is better described as a potential malpractice action.

I had absolutely no experience with computers, but I did have an HP-97 programmable calculator for which I had written several programs. I also started reading magazines with an emphasis on microcomputers. The prices seemed right, but most software required a disk operating system, which would automatically run up the initial price.

With all of this in mind, we started the "great hunt," and, finally, we have our system in. It is probably the most inexpensive word processor available, and, best of all, it works! A secretary can quickly learn to operate it.

The Hardware

We have installed the following:

1. A 32K Exidy Sorcerer with the Word Processor Pac (Exidy, Inc., 390 Java Drive, Sunnyvale CA 94086).
2. A Leedex monitor (Video 100).
3. A Comprint 912 printer, equipped with a parallel board designed for the Exidy. (Computer Printers International, Inc., 340 E. Middlefield Road, Mountain View CA 94043).
4. A Sanyo Memoscriber cassette dictation machine, model 8000A.
5. An IBM Selectric II typewriter, equipped with an Escon typewriter interface unit (Escon Products, Inc., 171 Mayhew Way, Pleasant Hill CA 94523).

The Exidy Sorcerer is a production-line model, equipped with 32K RAM. For those of you who have never heard of the Sorcerer, here is a quick summary.

The Sorcerer has a Z-80 CPU that is in a common enclosure with the keyboard. It will handle dual cassette units, with or without motor control, at 1200 or 300 baud. It is equipped with a parallel port and a serial port stated by Exidy to be RS-232. We found that the Comprint would not run on the serial port at a speed in excess of 300 baud. Also, the Escon typewriter interface would not run on the serial port. We suggest that you check out any serial peripheral before you buy it.

The system outputs the full ASCII set, uppercase and lowercase. In addition to using it as a word processor, you can also program it in BASIC and other languages, depending on the peripherals. The unit also accommodates an S-100 bus. We contemplate the purchase of the bus to increase the memory capacity to 48K. We are told that Exidy is coming out with a 48K unit shortly. That extra memory will be helpful on long documents.

The Comprint is a compact, fast printer that prints a fully formed (9 × 12) dot matrix character readout on aluminized paper; we have heard that a white-surfaced paper will become available. (Meanwhile, the aluminized paper makes excellent photocopies on a xerographic or electrostatic copier.) It comes with a parallel board that has been modified for the Exidy. It will plug directly into the Exidy parallel port upon fabrication of a cable, a task most computer shops can perform.

It runs at incredible speed. We ran 450 lines through it in a few seconds short of three minutes. We use it for all draft work, and the copies have been acceptable to all reviewing parties. In fact, we have used a photocopy of the Comprint printouts as an original on more than one occasion. The Comprint can be leased or rented from Leasametric (1164 Triton Dr., Foster City CA 94404, 1-800-227-0280); the monthly rental is low, and it keeps down the initial investment.

In the office we already had a Sanyo Memoscriber, a cassette dictation machine that has worked well with the Exidy. It is expensive, about $400, and I am not suggesting that this has to be used. However, it is essential to get a machine that works unfailingly with the Exidy, and not every cassette does. Be sure to check this out before committing yourself to buying a tape unit.

The Escon typewriter interface sells for about $600, depending on the length of the cable, etc., including installation. It consists of an external, 12 × 8 × 5 inch interface box that plugs into the parallel port of

The Exidy Word Processor at work. (Photo by Ctein Photography)

the Exidy. Solenoids are installed inside the typewriter. The exterior dimensions of the typewriter are not changed, and no modification of the typewriter is required. Escon has a letter from IBM, which states that new-machine warranties and service agreements are not voided by the installation.

The interface recognizes the full ASCII set and converts it to the language code of the Selectric. (Escon tells me that it is also compatible with the Remington SR-101 typewriter.)

The output rate has been set low: 12.5 characters per second, or about five seconds per line. The key matching has been set for the American Standard keyboard, although Escon will furnish special PROMs for $25 for special Selectric elements, such as foreign languages.

The printer turned out to be one of our biggest problems in setting up the system. For one thing, the price for so-called "daisy wheel" printers is high. For another, we wanted to be able to manually add some text to a machine-printed document, if necessary, which meant that a full keyboard was a must. (Our typewriter is fully operable manually.)

Also, there was the matter of service. We have been able to persuade our local typewriter house to service the typewriter for us. However, with the print output so low, we need a high-speed printer for drafts, and having the alternative printer keeps down the wear and tear on the typewriter.

The Selectric II is better suited for this application than the Selectric I. You can print more pages without changing the cartridge on the Selectric II than you can on the older model.

The Software

The word-processing program is contained in a "word-processing pac," which looks a little like the cartridge in a video game. It plugs into the side of the CPU; no additional interfacing is required.

The WP works in two modes: EDIT, the most frequently used, and COMMAND. In EDIT, a blinking cursor travels across the middle of the screen on an edit line. The text is typed at the cursor point, and as the text appears on the screen the cursor travels across with it. When the end of the line is reached, the cursor drops a line, goes to the left and continuously brings in the next line of the text being typed.

The user has total control over editing. The text can be scrolled up or down, past the cursor, and changes can be made quickly. The text can be easily expanded to insert new material, or old text can simply be typed over. The insertion of a new paragraph, for example, requires pressing only one key. All text to the right and below the cursor is pushed down, and any amount of material can be added. When the text is closed, all text moves up and wraps around the insertion.

Deletions are accomplished by pressing a delete key, which places a mark over the text to be removed. Pressing the clear delete key wipes all text so marked. All old text wraps around to fill in the gap.

A brilliant touch is that most of the text-editing functions are performed on the touch pad in the right-hand corner of the console. (See Fig. 1. Note that, unlike many other systems, no dual-key operation is required. The control key never has to be used in this system.) Arkay Engravers, Inc., 2073 Newbridge Road, Bellmore NY 11710, sells a set of replacement keys with the editing commands engraved on them. The keys come in red, black, beige, blue or gray and cost $9.50 for the complete set or $6.50 without the arrows, postage paid.

COMMAND Mode Functions

At the top of the screen is a continuous readout of the line number and character count for the line. Available memory can be determined by typing "m" in the COMMAND mode. The system does handstands when it is in the COMMAND mode. In that mode, overall control is obtained, gross changes can be made and the format is set up for printing. A partial list of functions follows.

SEARCH AND REPLACE: This function enables the user to hunt for an existing string in text, for example, "JOHN J. JONES," and replace it, for example, with "JOHN R. JONES." Two options are available: the user can automatically replace the old string with the new one or, by inserting an asterisk in the command, the search stops at each find of the old string. If the user wishes to replace the old string, he can press the RETURN key. The old string is replaced and the hunt continues for the next "find." If the user does not wish to replace the old string, he can press the space bar, and the old string will be left intact and the hunt will continue. If the asterisk is omitted, the old strings will all be replaced automatically, with no opportunity for the user to intervene. Without user intervention, the system will replace dozens of strings in a split

INDENT		↑ CURSOR UP	
EXPAND/ CLOSE TEXT	← CURSOR LEFT		→ CURSOR RIGHT
SCAN CURSOR		CURSOR DOWN ↓	
EDIT/ COMMAND	SOFT HYPHEN	CLEAR DELETE	DELETE TEXT

Fig. 1. Numeric pad as used with the word processor.

second; we then have to figure out where the changes have taken place.

The total number of combined characters for search and replace is about 120, and the system will search over 200 times without the necessity of having to reenter the command.

DELETE: By entering a "d" in the COMMAND mode, followed by the number of lines to be deleted (or no number if all text below the cursor is to go), you can remove the text below the cursor. If more than about 1000 characters are to go, the program gives the user an opportunity to change his mind. This function is extremely helpful in removing several lines at a time and does not require use of the rubout key. The DELETE routine is a valuable function in wholesale editing. We use it for setting up customized documentation where, for example, 5000 characters on a master document will not be needed for the particular job we are doing.

KILL FILE: To kill a file of text, the user types "k" in the COMMAND mode. The program causes "really?" to come on, and if "y" is typed, the entire file is killed. However, text that is placed in the holding buffer remains and can be brought out of hold position and worked with.

HOLDING BUFFER: Built in is a holding buffer that will hold and separate from the editing buffer any amount of text up to the total memory of the system. To use it just type "hn" in the COMMAND mode, where "n" is the number of lines below the cursor to be held. (If no "n" is entered, the hold will be of all text below the cursor to the bottom of the file.)

When the RETURN key is pressed, the text to be held disappears from the screen. It can be brought back anywhere in the text by positioning the cursor, typing "u" and pressing the RETURN key. Most important, it can be brought back repeatedly, if the amount of text in the holding buffer does not exceed 50 percent of the available memory. If it does exceed this amount, the buffer will empty itself.

We use the hold routine for duplicating clauses. The routine also has potential for multiple copies of form letters and mail merge routines. "H0" clears the holding buffer.

PAGE TITLING: The page titling, including page numbering, is one of the weak points of the system. Page numbering is at the top of the page, not the bottom. This means that if the first page is not numbered, the menu has to be changed in text to eliminate the numbering for page 1. However, as a practical matter, it is of no consequence. On the typewriter print, the operator only has to strike the page number as the page is taken from the machine. The Comprint can be set to automatically spit out eight blank lines between every 58 lines of print, and the paging can be quickly done manually at that point.

TAB SETTINGS: To set tab stops, the user only has to press "z" in the COMMAND mode, and the tab matrix comes onto the screen and looks much like a typewriter tab line. Tabs can be set across a 120 character line, and 60 tab stops are possible. (CR escapes back to text.) Pressing TAB key moves the cursor just as the same key would move the typing element on a typewriter. (The movement of the cursor by the TAB key places space marks in the indentations.)

SOFT HYPHEN: There are two hyphen keys in the system. One is the regular hyphen in the upper-right portion of the keyboard and is referred to as a hard hyphen. It is used to hyphenate words that should always be hyphenated, such as mother-in-law, irrespective of the position of the word in the text.

The soft hyphen is on the edit pad and sets up an optional hyphen. Suppose, for example, that the user is typing the word "ambidextrous" and that word is likely to end up near the end of the line. If the word will not fit within the line length in the final edition, the processor will normally pick up the entire word and move it to the next line. If it is only one character too long, there will be a hole at the end of the previous line eleven characters wide. If the soft hyphen key has broken the work at "ambi," the program will break the word at that point if it has to break the word at all. If the word ends up in the text so that it does not have to be broken the program will remove the hyphen. This is an extremely useful device for cleaning up the right edge of text, with or without the use of the right-edge justification format. The soft hyphen can be entered at the time the text is being entered, or it can be done later.

LINE LENGTH: The line length can be changed at any time. (Default is 63 characters, which size conveniently happens to be the screen width and also matches a typical typewritten line.) All that is necessary to immediately change the line length is to type "ln" in the COMMAND mode, where "n" is the desired length (up to 120). A special vertical dashed line appears at the right edge of the screen and reflects the new length. (The character counter also counts any longer line.)

This feature would seem to have special application for professionals such as accountants and statisticians working with figures. Financial statements or tables often use printing on the long side of an 11 inch or 14 inch page; if the typewriter platen will accommodate that length, this feature can be of great value to such persons.

PRINT FORMATTING: The format for printing can be adjusted in numerous ways. Space between the lines, right-edge justification, spaces at the end of a page can all be set on the print menu. In addition, many of the format options can be set (or changed) in text.

GRAPHIC MARKS: There is a series of graphic marks, which are laid down in text by means of pressing the graphic key and a number from 1 to 9. Some of them are used for special purposes, and I will omit reference to them here. However, some are so fundamental that we would not have purchased the system if their functions had not been available.

Graphic 5 is the instruction to set up a change of format during execution of a print. For example, all that is necessary to change from single to double space during the print is to expand the text and insert on the left edge (GR5) / / / / 02(CR). When the print reaches that line, it reverts internally to the print menu, skips the first four items (because those are shown as slashes), and when it encounters the "02," it changes the setting for the number of returns between the lines from whatever it was to "2." From that point forward you get double-spaced text until you want to change it again. Other changes that can be made are lines per page, number of returns at page end, page titling (on or off), indentation, right-edge justification (on or off). The mark is saved on tape and, once inserted in text, stays there until deleted, but it is not printed.

Graphic 9 places a stop mark in the text for stopping a long deletion and putting special holds into the holding buffer. This is helpful when the deletion or hold is to the middle of a line or is in the middle of text and is so long that it is not practical to count lines.

Other graphic marks are designed for form feed, merge routines and so forth. However, a couple of them are useful for print control. Graphic 8 will stop the print completely. Graphic 3 will stop the print temporarily, and it can then be started again by tapping the space bar. (It is my understanding that Exidy is coming out with an updated manual that should explain the workings of all the graphic keys in more detail.)

MACRO-PROGRAMMING: It is possible to write in a program at the end of text that will cause the system to go into automatic execution of a series of commands. All that is necessary is to key in a series of instructions, each followed by a press of the RETURN key. When they are finished, they can be placed into a special macro-buffer and then executed repeatedly. This is valuable for two-column printing and multiple prints. The possibilities are endless, and the system, according to the manual, will take up to 512 characters.

CASSETTE READ/WRITE: Our system stores and plays back text on cassette. The process is quite simple but requires some attention to detail.

There are two methods of cassette read/write: with and without motor control. We are using only non-motor control. If the user wishes to save text on tape, the tape unit is turned on in the record mode, and the user types "W/c2" in the COMMAND mode and presses the RETURN key. The program then asks for a filename and, in non-motor operation, the digit "0" is entered, and a filename, if desired, followed again by the RETURN key. The text then starts down the pipe to the cassette unit. When it is finished, the screen will show the number of characters of text saved and return the text to the screen. The cassette can then be turned off.

To play text back to the computer, the user types "r" in the COMMAND mode, followed by the RETURN key and, when the program asks for a filename, types a slash (/) and the RETURN key. Then the cassette unit is turned on in play mode and the text comes into the computer. When the text is fully loaded, the phrase "END OF FILE" appears on the screen and the text comes up on the screen. If there is an error on the tape, the read stops and "DEVICE ERROR" appears, followed by whatever text was loaded.

To make all the above happen, the user must have a good, reliable tape unit. It must be well shielded. When tape is being recorded, static-producing equipment may place a glitch or two on the tape, and on playback, "DEVICE ERROR" may show up instead of "END OF FILE." (Don't turn on a buzz saw while you are recording tape.)

To protect ourselves from losing text, we use the holding buffer to hold a short document and then make sure the tape comes in error-free. If not, we pull it out of the buffer and rerecord it. For a long document, we type "1/" when the computer asks for filename and then record it. The user then types "100 r5/d20" when reading the tape back and presses the RETURN key when there is a request for a filename. After the cassette is turned on and starts to play back the text, the computer continuously reads the text back five lines at a time, deletes it and signals "END OF FILE" if the tape is error-free. It also asks for a filename, which is ignored (if not in motor operation) by pressing the ESCAPE key. If there are some glitches on the tape, "DEVICE ERROR" will appear and we rerecord.

Good maintenance of the cassette transport is essential. We have eliminated a lot of problems by regular cleaning and demagnetizing of the heads. Obviously, a disk system eliminates a lot of problems. We have not put one in yet and do not plan to do so for some time. For one thing, we want to see what develops with the technology, especially storage capacities. A single page of text, 8 1/2 × 11 inches, typed with narrow margins, is only about 2000 characters, or less. We do not believe, at present, that a multi-megabyte disk system for our purpose is economically sensible, since we do not plan to write the "great American novel."

For the moment, we have thousands of characters of text on cassette tape, which come into the computer any time we want them. So, we will wait before deciding about disks. (Remember: The whole idea of this system was to get it functioning at a low price.)

Summary

This has been a long article, and a good deal more could be added. Suffice it to say that, in my opinion, the Exidy Word Processor is one of the best bets around for word processing for the professional office. There have long been very expensive systems for the professional, requiring a large capital investment and specially trained personnel. This system requires neither and brings to the business office a capacity which has, for too long, been exclusively for the big operation. ■

Reader Service—see page 227

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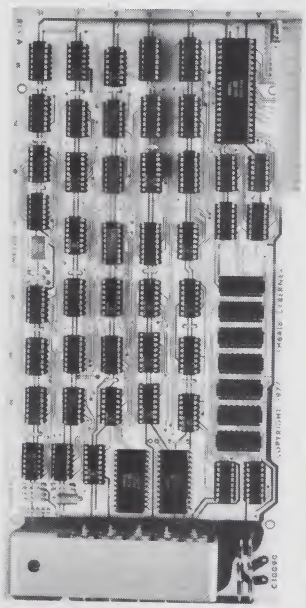

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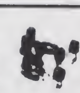

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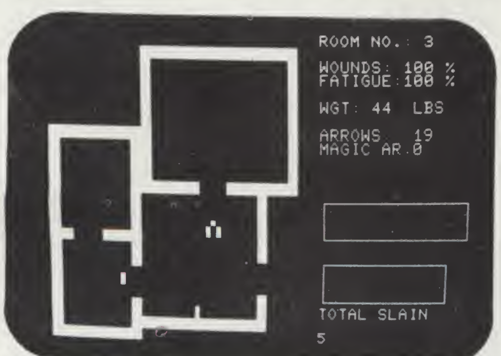

Actual photo of screen during a Dunjonquest game.
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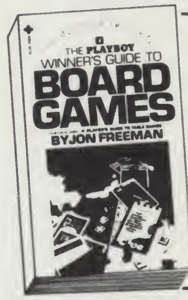

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TRS-80 to S-100 Adapter

This evaluation of the Mini-8100 follows up an earlier article on its "big brother."

Rod Hallen
State Dept.-Accra
Washington DC 20520

Whereas the HUH 8100 that I described in "HUH?" (*Microcomputing*, July 1979, p. 40) is one of the largest printed circuit boards that I've seen, the Mini-8100 is tiny by comparison. The completely optioned full-size 8100 contains, in addition to the TRS-80 to S-100 adapter, a serial I/O port, a parallel I/O port and sockets for 16K of RAM.

The Mini, which is shown in the accompanying photo, has only the S-100 adapter circuitry, but it should be suitable for many applications. As you can see, it has room for four S-100 sockets. If you don't need the I/O and RAM options of its big brother, the Mini is for you.

One interesting note and a word of caution are in order. The adapter circuitry is the same as on the full-size 8100, but because of a unique feature of the Mini, the S-100 boards plug in backwards. The word of caution is because the Mini does not use card guides, and it would be easy to plug in a card or two facing the wrong direction. Strange, mysterious and potentially disastrous things can result from such action.

I have been known to attempt to insert boards backwards in my Z-2 card cage, but because of the card guides and the offset edge connectors, it can't be done. The Mini does not come with an enclosure, but if one does become available, it should incorporate card guides. A dexterous hobbyist could easily fashion his own wood or metal enclosure.

The Mini lacks card guides because it is really two circuit boards in one. In the middle of the board, just below the first S-100 socket, is etched a standard S-100 card edge. Slicing the board in half along the line of the socket results in a card that will plug into an S-100 socket.

That is the explanation of the difference between the Mini-8100 and Mini-8100S versions shown in Table 1, each of which comes in kit and assembled forms. The 8100S is the one that plugs into an S-100 socket.

Editor's Note: The Mini-8100 is now being sold by California Computer Systems, 250 Caribbean, Sunnyvale CA 94086.

	Kit	Assembled
Maxi-8100—Basic unit	$185	$245
RAM support option	45	75
I/O option	85	115
Five extra connectors and guides	45	75
Total if purchased separately	$360	$510
Total if purchased together	$295	$375
Mini-8100 Kit—includes one S-100 connector		—$115
Mini-8100 Assembled—includes four S-100 connectors		—$155
Mini-8100S Kit—S-100 plug-in board		— 95
Mini-8100S Assembled—S-100 plug-in board		—$125

Table 1. The various versions of the HUH 8100 and their prices.

The Mini-8100

The Mini-8100 supports all of the S-100 cards described in my previously published review of its big brother. As mentioned above, the adapter circuitry for both boards is the same, and various memory, I/O and special applications cards are plug-in compatible. The prohibition against cards that call for DMA and cards that cause the processor to wait for more than a millisecond or so still applies. This is because of the TRS-80's dynamic memory refresh requirements.

The S-100 cards face to the rear in order to allow the edge connector contacts etched on the board to be on the correct sides of the Mini-8100. I would imagine that the Maxi-8100 could have had its S-100 sockets oriented in the same direction, but unless you have both versions, the difference won't present any problems.

An external, unregulated +8 and ±16 volt power supply is needed, and the current requirements of the Mini will depend almost entirely on the hunger of the cards plugged into it. A specific commercial supply is recommended by HUH, but you can build your own if you like. Mine is left over from my first personal computer.

Although my version was factory assembled, I don't think that putting it together from a kit should be much of a problem (12 ICs and a couple of dozen other components shouldn't take more than an hour or so to install). The Mini is so new that I haven't even seen the manual yet, but if it follows the line of the full-size 8100, it will be complete and easy to understand.

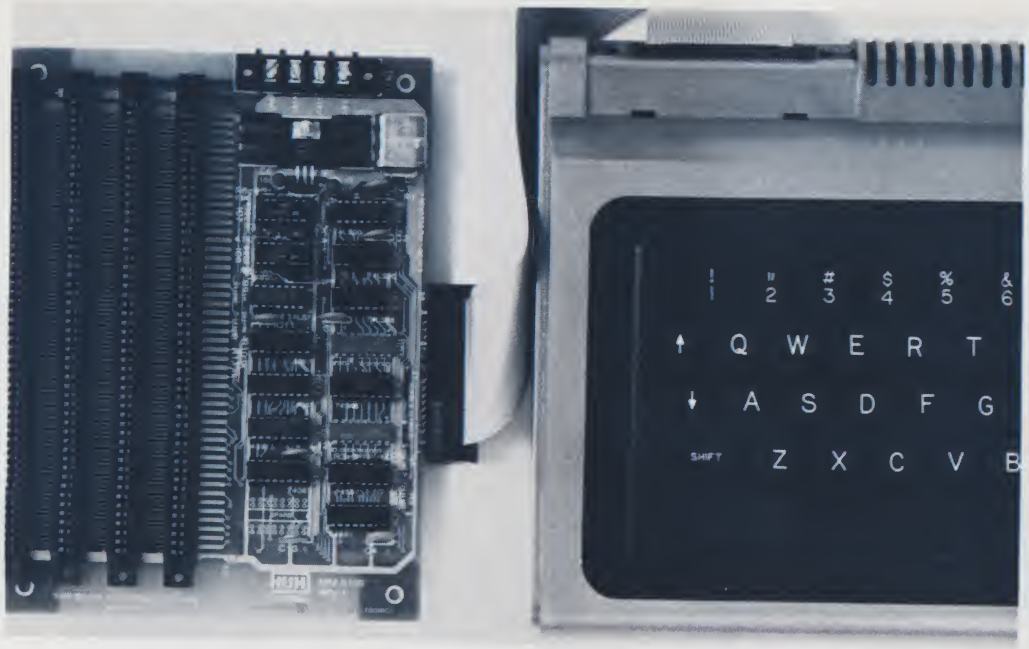
Mark Garetz, the president of HUH Electronics, 1429 Maple St., San Mateo CA 94402, assured me in a phone conversation that all factory-assembled boards are tested 100 percent and that none are shipped unless they pass all tests. This should be reassuring to potential purchasers. I have not had any problems with either my Mini or Maxi-8100.

Physically, the board is well made. Solder masking helps to eliminate solder bridges during construction, and component identification is silk-screened on the top of the board. All ICs are socketed, and there are no options to worry about. The bare board stands on four rubber feet; there isn't any flex when S-100 boards are plugged into it.

All you have to do is connect your power supply, run the ribbon cable between the Mini and your TRS-80 expansion port and plug in your S-100 cards. You can use the expansion port on the back of the keyboard unit or the one in the Radio Shack expansion interface. It is easy to get the ribbon cable turned over on one end or the other, so care should be taken with its installation.

The Mini-8100S

Although the Mini-8100 and 8100S are identical except for the S-100 connectors on the 8100, the way they are used is different. The 8100S is designed to plug into a regular S-100 socket. Inserting this into any



The Mini-8100 TRS-80 to S-100 adapter with its ribbon cable plugged into the TRS-80 keyboard-CPU unit. The power connector can be seen in the upper right-hand corner.

S-100 mainframe card cage and removing the present CPU card would allow the TRS-80 to access any of the boards installed in the mainframe. This is, of course, subject to the same DMA limitations mentioned above.

Or you could get a motherboard from Godbout, Thinker Toys, Artec or Vector and make your own mainframe. In either case, the 8100S derives its power from the S-100 bus; no direct power connection to the board is necessary.

I have the Mini-8100 with four S-100 connectors on it. One of the first questions that came to my mind was, "If I wanted to convert the board to the S model at some later date, could it be done?" At first glance, it appears to be only a matter of carefully cutting the board in half. A fine-toothed hacksaw should do it.

After a second, more thorough, examination, I decided that the modification was not practical. The S-100 card edge contacts etched on the board are covered with the solder masking material, which would have to be removed. The card edge would also have to be cut narrower to fit into an S-100 socket. And finally, it does not appear that the card edge contacts are gold plated under the solder masking. It would, therefore, be best to decide which version fits your needs before you make your purchase.

Conclusions

For a more complete discussion of the 8100 adapter circuitry and the types of S-100 boards that I've found work well with it, see the 8100 review mentioned at the beginning of this article.

At the present time my TRS-80 and my Cromemco Z-2 are talking to each other through back-to-back RS-232 serial ports. But this method of inter-computer communications has its limitations. Both machines must be tied up running interface routines while the information exchange takes place. This does, however, give the TRS-80 access to my full-size CP/M disks and high-speed line printer.

My next experimental step is to use the 8100 to tie the two buses together. Each computer should then be able to directly access the memory of the other. Some hardware and software synchronization will be necessary so the two processors don't interfere with each other, but that type of challenge is what makes personal computing so fascinating!

Between the HUH Maxi-8100, Mini-8100 and Mini-8100S, computer hobbyists (and businessmen, too!) who want to increase the versatility of their TRS-80s have a wide range of options to choose from. And the almost limitless variety of S-100 compatible hardware is easily within their reach.■

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Intermix typefaces without skipping a beat. Under software control, the Media 12/7, with its built-in Zilog Z80 microprocessor, can intermix a variety of typefaces. Changes in fonts can be accomplished by a single operator command. No balls or daisy wheels to replace. As many as 11 typefaces can be stored in ROM within the printer.

Capable of reproducing signatures in anyone's handwriting (option), the Media 12/7 can also generate proportionally-spaced characters for printed documents and reports.

Media 12/7 control functions. A few simple commands will control a wide variety of text handling functions. The highly sophisticated software resident within the printer relieves the user's software of many routines needed in word processing systems, thereby freeing valuable computer time. The following features are easily controlled by the operator:

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Ragged right	Flush right
Justification, with or without letter spacing	Centered Text

Parameter Controls

Typeface selection	Set/clear underline
Form selection	Form length
Line length	Word space
Left margin	Letter space
Indentation	Line height
Ribbon usage	Repeat character
Insert sequence	Draft mode
Insert character	

Print Positioning

Line feed	Negative line feed
Half line feed	Negative half line feed
Form feed	Absolute horizontal tab
Absolute vertical tab	Forced escapement
Forced leading	

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Actual Print Samples

Helvesan Draft (one pass font)

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high quality font which is ideal for the production of

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Reader Service—see page 227

Escon's Selectric Interface

The author sees this interface as "an inexpensive solution to hard-copy hassles."

Stephen Gibson
PO Box 38386
Los Angeles CA 90038

It isn't easy to find an inexpensive, but dependable, Selectric printer. By now you've read all the ads you'd care to see for some time. Perhaps you've been confused by the sometimes incredible price spreads ranging from a paltry $350 to well over $3000! The apparent fact is that nearly all the ads claim to have a new or used Selectric that should simply "plug in." But why the price spread? Well, it seems, if you haven't already guessed, that the little secret "gotchas" are a cross between your having to do a phenomenal amount of hardware and software interfacing or leaving it all up to someone else.

Is It Too Late?

I hope you haven't already succumbed to one of those marvelous ads extolling the utter simplicity of converting an old Selectric to work with your particular computer. If, by chance, you've already taken the plunge, you may have discovered that your "cheapo" deal on a " just removed from service" unit wasn't such a good deal after all.

The type ball wasn't anything like those on the Selectrics you've seen, was it? And that serial-interface thingy they told you was included turned out to be a UART alright . . . but you realize now that you must write some software to include carriage return nulls before it will really work! Or how about that kit that has you mounting a big plate of goodies between the top and bottom or, even worse, cutting holes in your brand new Selectric! Had enough? Then consider for a few moments a discovery I made that may be the inexpensive and simple solution for you.

Make the Conversion Yourself?

But do it wisely. That is to say, find an ultra-simple software and hardware way to do it. Perhaps you already have a Selectric or know where you can get a "deal" on a reconditioned one. But you've still got to find that super-simple interface.

Enter ESCON with their solenoid assembly and little "blue" box (see Photo 1). Inside is a 6502 micro that's programmed to do the right thinking for those solenoids. The code conversion and character buffers are all taken care of. All you do is mount the solenoids (easy), solder a cable at both ends (easier) and plug it into the blue box (easier still). Any model—I, II or even the correcting model—Selectric can be modified. Furthermore, you don't have to cut or drill holes to mount big, ugly plates that change the appearance of your Selectric. In fact, you'd never know that it had been interfaced unless you noticed the extra cable at the back.

Photo 1. Two manuals, a little blue box and a bag of goodies make up the ESCON Selectric interface package.

How It's Done

ESCON has figured out a way to use the existing screw holes to mount the solenoid assembly. It's probably a stock IBM item! No drilling or tapping is necessary. The solenoids simply do the business your fingers do topside. A hefty 30 volt

S-100

Key

1. Power Supply
2. Interface Electronics
3. Universal Interface
4. Computer
5. Typewriter

A. Function Solenoids

B. Select Solenoids

C. Shift Solenoid

Universal

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Fig. 1. An S-100 plug-in card and a universal terminal model are offered. The S-100 card has a 64-byte buffer. The universal model has a 6502 microprocessor and a 512-byte buffer.

power supply back in the little blue box drives the solenoids with the added logic of knowing when the Selectric is fully powered-up before typing, therefore obviating the possibility of permanent damage to your machine. Note: Not all interfaces have this feature. It may not seem important now, but later on, after you've suffered a walloping repair bill, it will!

The blue-box electronic section converts the ASCII code to feed the solenoids. It is here that you interface your computer. ESCON offers a number of options (see Fig. 1). They have a less expensive S-100 board (no 6502) that simply plugs into your Imsai, Poly, Altair or whatever. You select the status and data port you want with DIP switches. A 64-byte buffer is included with all the timing and code-conversion logic.

The universal interface model allows you to treat the Selectric as a normal terminal-output port. You can wire the unit up to a parallel, RS-232 or IEEE-488 port. DIP switches are used for handshaking. The 6502 microprocessor uses an on-board 512-byte buffer to make your serial-software interfacing a piece of cake! You even have a test mode that prints all the characters . . . very handy if you ever need to do troubleshooting.

Getting Started

The very idea of digging into the guts of a Selectric gave me an uneasy feeling . . . at least until I opened the instruction book. If you've ever done any modification or construction or even a simple installation of anything even remotely related to microcomputers, you know that most documentation is poor. Not so with this conversion. Large drawings and simple language are what I found (see Photo 2).

I began by soldering wires to

Photo 2. Large drawings and simple language make the solenoid installation easy. No other assembly is necessary.

the solenoids. Then I followed the detailed instructions on how to remove the top of the Selectric. You lift the entire unit up to work on the bottom. Various parts are removed to make way for the solenoid assembly. If you drop a screw or washer on the floor, don't worry. ESCON has provided 100 percent spare parts for just about everything you touch. Next, I mounted the solenoid assembly in the existing holes. It didn't seem all that difficult after I'd done it (see Photo 3). Incidentally, they include an upgrade part for very old Selectrics.

Replacing the parts I had removed became somewhat of a chore. An hour and a half had passed since I'd begun, and I was waiting for the really hard part. Could I get the job done in one evening? Would the typewriter still work, even if the conversion didn't. Even worse, I needed the typewriter in the morning! Naturally, I began dropping things. Screws and little metal parts were everywhere. Then I remembered the spares. It was a simple matter to simply replace the few parts now buried somewhere in the rug.

Finally, I had to solder the interface cable to the solenoids. ESCON labeled every wire. The color code on the cable was easy to follow. Tying the wire bundle in place was difficult, though. Positioning the wires within the mechanism must be done carefully, because various pulleys and levers can be jammed. All that was left for me to do was to snake the cable out the back after splicing two wires to the motor line. I spliced a .1 uF/600 V capacitor in parallel with the motor leads to stifle an annoying glitch that used to occur on the line whenever I turned on the Selectric. I don't know if the ESCON unit or the capacitor cured the glitch. It's gone, though. And so was a mere three hours total for the conversion.

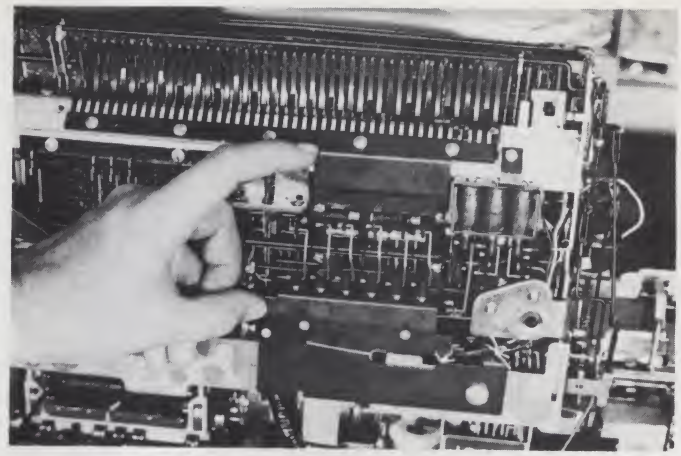

Photo 3. Exisiting screw holes are used to mount the solenoid assembly seen between my thumb and index finger.

Testing It

I plugged in the unit after going through the ohmmeter checks called for in the instructions. Too bad the book is not specific as to where to look or what to do if you do have a short. The idea of unraveling a lot of twine and electrical tape was not too appealing. Fortunately, the unit worked the moment I plugged it in.

Later, I noticed a couple of mistyped characters. Turning to the mechanical-adjustments section of the book, I found a helpful procedure for determining the source of the problem. I needed to bend a bar on one of the solenoids . . . simple; it worked. The book is specific as to the kind of adjustments necessary. Solenoid travel distances and clearances are spelled out so you can "make it work" no matter what the problem might be.

Handshaking is carefully covered so that you can operate at maximum speed. You can use the direct method where a line such as Ready to Send (RTS) is enabled. Or you can choose to use a software method where the ESCON interface sends a character back to your computer when the 512-byte buffer is full. You can choose what that character will be with DIP-switch settings. Or your computer can send handshake characters to the ESCON interface.

Having a microprocessor in the unit does improve your options. Naturally, you can opt for the simple way and set your serial baud rate for 10 to 15 character per second (top end for most Selectrics) and let the byte buffer handle the overload. The RS-232 serial port supports baud rates from 50 to 19,200 baud.

My unit has been dutifully typing letters, reports and threatening notes for nearly eight months with no problems at all! By the way, I later learned (after the fact) that the installation of the solenoids, if done with reasonable care, does not void your new-machine warranty. It seems IBM reviewed the interface and gave ESCON its blessing. That alone is testament to the design.

Price was my reason for buying. The S-100 version is $496. The parallel-port version is $525. And the RS-232 version is $549. I was surprised when I saw all the spare parts and goodies that were included. They even included electrical tape. I'm very happy with my unit simply because it was easy to install, did what it was supposed to do and saved me a lot of grief. ■

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Telephone Bill Analysis

Anyone who makes extensive use of the telephone will be able to use this program.

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One of the most important parts of any business today is the telephone. Every business relies heavily upon it to take orders, call for merchandise and take care of the hundreds of small problems that beset the businessman every day.

Depending on the type of business, the telephone might represent a major expense or might just be buried along with the other expenses of operating a going concern. In any case, it will pay most managers to step back and take a long, hard look at the reduced cost lines available from Ma Bell.

The function of this discussion and accompanying program is to help the manager reduce his telephone bill by analyzing the toll calls that are made and compare them to the alternate reduced-cost toll lines available from the telephone company.

WATS Lines

The first of these lines to be discussed is the Wide Area Telephone Service, or WATS, line. WATS lines are available to cover several different geographical areas and are billed at a flat rate per month. For this monthly flat rate, unlimited calls, up to 240 hours per month, are allowed. Calls beyond 240 hours per month are billed in addition to the flat rate, but are still less expensive than direct-dial toll calls.

To illustrate how a WATS line works, let's look at WATS area 2 out of the Harrisburg PA area. The flat monthly charge for this line is $1325, plus tax, and the line covers all calls into the area codes listed in Fig. 1.

As you can see by a little elementary arithmetic, if you make enough calls into the covered areas, you really do have a "telebargain." For instance, if you made 3000 four-minute calls a month (well within the 240 hour limit), each call would cost less than 44¢. That's quite a bargain compared to the direct-dial toll rates. Also keep in mind that calls can be made at any time of the day or night with no change in rates.

Foreign Exchange Trunks

The next type of line to be considered is the foreign exchange trunk. This type of line provides a number outside of your local call area. For instance, if you are in New York City and want to have a local line in Baltimore, you simply buy the local service in Baltimore plus a flat mileage rate between the two cities. Then when you pick up your phone in New York that is connected to this line, you have the same local dialing area as all the other phones connected to that Baltimore exchange.

Here again, we can make a mathematical comparison between the cost of a foreign ex-

201	304	609
202	315	617
203	401	703
212	413	716
216	419	802
301	516	804
302	518	914
	603	
	607	

Fig. 1. Area codes covered by the WATS area 2 line for calls originating from the Harrisburg PA area.

Program listing.

```
5 ' -----------------------------------------------------------------
10 '---------------        TELEPHONE BILL ANALYSIS          ----------
20 '---------------          TRS-80  LEVEL II               ----------
30 '---------------         WALTER K. MCCAHAN               ----------
40 '---------------           AUGUST  1978                  ----------
45 '-----------------------------------------------------------------
50 DIM A(250),D(250),E(250),N(250),M(250),C(250)
60 CLS
70 PRINT"        THIS PROGRAM WILL ANALYZE TOLL TELEPHONE CALLS"
80 PRINT"        TO ENABLE THE USER TO MAKE A DECISION"
90 PRINT"        AS TO THE LEAST EXPENSIVE WAY TO MAKE"
100 PRINT"        TOLL CALLS"
110 PRINT
120 INPUT"WHEN READY TO PROCEED PRESS ENTER";X
130 CLS:PRINT:PRINT
140 PRINT"FUNCTIONS AVAILABLE"
150 PRINT"        1. TO BUILD FILE OF TELEPHONE CALLS"
160 PRINT"        2. TO CORRECT A CALL ALREADY ON THE FILE"
170 PRINT"        3. TO LIST CALLS BY AREA CODE"
180 PRINT"        4. TO LIST CALLS BY AREA CODE & EXCHANGE"
190 PRINT"        5. TO LIST ALL CALLS TO ONE NUMBER"
195 PRINT"        6. TO LIST ALL CALLS MADE ON ONE DAY"
200 PRINT"        7. TO SAVE THE DATA FILE ON CASSETTE"
205 PRINT"        8. TO LOAD A DATA FILE FROM CASSETTE"
210 PRINT
220 INPUT"TYPE THE NUMBER OF YOUR CHOICE AND ENTER";B
230 ON B GOTO 300,1600,550,800,1100,1900,1400,1500
```

change line and the cost of all direct-dialed toll calls into that local call area. Once again, rates and information are available from your local telephone company.

Tie-Lines

The last type of line to be discussed is the tie-line. This type of line connects two locations only. Each location can only call the other location, and no other numbers can be called. This kind of line is used when there is a need for long-time communications between two points. This line is often used to connect branch offices with the home office, warehouse to warehouse and computer to computer. As with all lines discussed, information and rates can be obtained from your local telephone company.

Information Required to Make a Decision

In order to make a decision as to whether the WATS line would be an expense-saving device, you need two sets of information. The first set, which is supplied by the telephone company, tells, by WATS line, what calling areas are covered and the cost of the WATS service. The second set, which is supplied by the accompanying program listing, tells you the historical total cost of your calls into each area. Then by comparing the total costs of calls into all covered areas with the WATS line cost that covers those areas, the savings to be gained by renting a WATS line will be readily visible.

The same kind of comparison is made regarding the foreign exchange line. Here the cost of renting the line is compared with the cost of calls into all exchanges covered by the line, as provided by the program.

The simplest comparison of costs is made when you consider the tie-line. In this comparison you need be concerned only with calls to and from two numbers. This information is also provided by the program and is easily compared to the cost of a tie-line. Illustrations of these comparisons are given in

```
240 END
300 CLS:PRINT:PRINT
310 PRINT"       THIS FUNCTION IS USED TO ENTER CALLS INTO"
320 PRINT"       THE DATA FILE.  WHEN READY TO
330 INPUT"       ENTER CALLS PRESS ENTER";X
340 CLS
350 PRINT"       TO CLOSE THE DATA FILE ENTER 9999 FOR
360 PRINT"       DAY OF MONTH."
380 PRINT
390 FOR I=1 TO 500
400 INPUT"      DAY OF MONTH";D(I)
405 IF D(I)=9999 GOTO 470
410 INPUT"      AREA CODE";A(I)
420 INPUT"      EXCHANGE";E(I)
430 INPUT"      NUMBER";N(I)
440 INPUT"      MINUTES";M(I)
450 INPUT"      COST";C(I)
460 CLS:NEXT I
470 PRINT:PRINT
480 P1=I
490 PRINT"      oK - DATA FILE IS CLOSED"
500 INPUT"      TO SEE FUNCTIONS AVAILABLE PRESS ENTER";X
510 GOTO 130
520 END
550 CLS
560 PRINT"       THIS FUNCTION LISTS CALLS INTO ALL AREAS COVERED
570 PRINT"       BY A WATS LINE
580 PRINT
590 PRINT"       A LIST OF AREAS COVERED BY THE VARIOUS WATS"
600 PRINT"       LINES IS AVAILABLE FROM YOUR LOCAL TELEPHONE"
610 PRINT"       COMPANY
620 PRINT"
630 PRINT"       WHEN YOU ARE READY TO ENTER THE FIRST AREA"
640 INPUT"       CODE, PRESS ENTER";X
650 CLS:PRINT:PRINT
660 INPUT"       ENTER AREA CODE";F
662 LPRINT:LPRINT:LPRINT:LPRINT:LPRINT
663 Q=0:R=0
664 LPRINT TAB(20)"LISTING BY AREA CODE"
665 GOSUB 3000
670 FOR I = 1 TO P1
675 IF F=A(I) GOSUB 4000
680 IF F=A(I) Q=Q+C(I)
685 IF F=A(I) THEN R=R+M(I)
690 NEXT I
695 LPRINT TAB(20)"TOTALS";TAB(40) R;TAB(48) USING "###.##";Q
700 PRINT"       DO YOU HAVE ANOTHER AREA CODE TO ENTER"
710 INPUT"         YES   OR   NO";G$
720 IF G$="YES" GOTO 650 ELSE GOTO 130
800 CLS:PRINT:PRINT
810 PRINT"       THIS FUNCTION LISTS ALL CALLS INTO ONE"
820 PRINT"       EXCHANGE. THIS FUNCTION IS USED PRIMARILY"
830 PRINT"       TO STUDY THE FEASIBILITY OF FOREIGN EXCHANGE"
840 PRINT"       LINES"
850 PRINT"       LISTS OF EXCHANGES COVERED AND COSTS ARE"
860 PRINT"       AVAILABLE FROM YOUR LOCAL TELEPHONE COMPANY"
870 PRINT
880 PRINT"       WHEN READY TO ENTER AREA CODE AND EXCHANGE"
890 INPUT"       NUMBERS PRESS ENTER";X
900 CLS:PRINT:PRINT
910 INPUT"       ENTER AREA CODE";H
920 CLS:PRINT
930 INPUT"       ENTER EXCHANGE";K
932 LPRINT:LPRINT:LPRINT:LPRINT:LPRINT
935 CLS:Q=0:R=0
938 LPRINT TAB(20)"LISTING BY AREA CODE & EXCHANGE"
940 GOSUB 3000
950 FOR I =1 TO P1
960 IF H=A(I) AND K=E(I) GOSUB 4000
964 IF H=A(I) AND K=E(I) THEN Q=Q+C(I)
968 IF H=A(I) AND K=E(I) THEN R=R+M(I)
970 NEXT I
975 LPRINT TAB(20)"TOTALS";TAB(40)R;TAB(48)USING"###.##";Q
980 PRINT"       DO YOU HAVE ANOTHER EXCHANGE AND AREA CODE"
990 INPUT"         YES OR    NO";G$
1000 IF G$="YES" GOTO 900 ELSE GOTO 130
1100 CLS:PRINT:PRINT
1110 PRINT"      THIS FUNCTION LISTS ALL CALLS TO ONE"
1120 PRINT"      NUMBER AND IS USED PRIMARILY TO DECIDE"
1130 PRINT"      THE FEASIBILITY OF INSTALLING A TIE"
1140 PRINT"      LINE."
1150 PRINT"      INFORMATION AND COSTS ON TIE LINES ARE"
1160 PRINT"      AVAILABLE FROM YOUR LOCAL TELCO."
1170 REM
1180 PRINT
1190 INPUT"      WHEN READY TO PROCEED PRESS ENTER";X
1200 CLS:PRINT
1210 INPUT"      ENTER AREA CODE";A
1220 INPUT"      ENTER EXCHANGE";E
1230 INPUT"      ENTER NUMBER";N
1235 LPRINT:LPRINT:LPRINT:LPRINT:LPRINT
1240 CLS:Q=0:R=0
1245 LPRINT TAB(20)"LISTING OF ALL CALLS TO ONE NUMBER"
1250 GOSUB 3000
1260 FOR I= 1 TO P1
1270 IF A=A(I) AND E=E(I) AND N=N(I) GOSUB 4000
1274 IF A=A(I) AND E=E(I) AND N=N(I) THEN Q=Q+C(I)
1278 IF A=A(I) AND E=E(I) AND N=N(I) THEN R=R+M(I)
1280 NEXT I
1285 LPRINT TAB(20)"TOTALS";TAB(40)R;TAB(48)USING "###.##";Q
1290 PRINT"      DO YOU HAVE ANOTHER NUMBER TO ENTER"
1300 INPUT"         YES   OR   NO";G$
1310 IF G$="YES" GOTO 1200 ELSE GOTO 130
1400 REM
1410 CLS
1420 INPUT"WHEN THE CASSETTE RECORDER IS READY PRESS ENTER";X
1430 CLS:PRINT:PRINT:PRINT"    NOW RECORDING FILE ONTO CASSETTE"
1432 PRINT#-1,P1
1435 FOR I=1TOP1
1440 PRINT#-1,D(I),A(I),E(I),N(I),M(I),C(I)
1450 NEXT I
1460 CLS:PRINT:PRINT
1470 PRINT"      RECORDING NOW COMPLETE TO SEE FUNCTIONS"
1480 INPUT"      PRESS ENTER";X
1490 GOTO 130
1500 CLS:INPUT"    WHEN CASSETTE IS READY PRESS ENTER";X
1502 PRINT:PRINT:PRINT"          NOW LOADING FILE FROM CASSETTE"
1503 INPUT#-1,P1
1505 FOR I=1TOP1
1510 INPUT#-1,D(I),A(I),E(I),N(I),M(I),C(I)
1520 NEXT I
1530 PRINT:PRINT
1540 PRINT"      LOADING NOW COMPLETE - TO SEE FUNCTIONS"
1550 INPUT"      AVAILABLE PRESS ENTER";X
1560 GOTO 130
```

```
1600 CLS:PRINT"      ENTER THE INFORMATION FOR THE CALL TO BE CORRECTED"
1610 PRINT:INPUT"        DAY OF MONTH";D
1620 INPUT"      AREA CODE";A
1630 INPUT"      EXCHANGE";E
1640 INPUT"      NUMBER";N
1650 INPUT"      MINUTES";M
1660 INPUT"      COST";C
1670 FORI=1TOP1
1680 IFD=D(I) AND A=A(I) AND E=E(I) AND N=N(I) AND M=M(I) AND C=C(I) GOTO 1740
1690 NEXT I
1700 PRINT"      CALL NOT FOUND IN FILE"
1710 INPUT"      TO TRY AGAIN ENTER YES - TO SEE FUNCTIONS AVAILABLE ENTER NO";G$
1720 IFG$="YES" GOTO 1600 ELSE GOTO 130
1730 REM
1740 CLS:GOSUB3000
1750 GOSUB4000
1760 PRINT"      ABOVE IS THE CALL AS IT APPEARS BEFORE CORRECTION"
1770 PRINT:PRINT "      ENTER THE CORRECTED INFORMATION"
1780 INPUT"      DAY OF MONTH";D(I)
1790 INPUT"      AREA CODE";A(I)
1800 INPUT"      EXCHANGE";E(I)
1810 INPUT"      NUMBER";N(I)
1820 INPUT"      MINUTES";M(I)
1830 INPUT"      COST";C(I)
1840 PRINT"      THE CORRECTED CALL NOW READS":PRINT
1850 GOSUB4000
1860 PRINT"      DO YOU HAVE ANOTHER CALL TO ENTER"
1870 INPUT"            YES    OR    NO";G$
1880 IF G$="YES" GOTO 1600 ELSE GOTO 130
1900 CLS:PRINT:PRINT
1910 PRINT"      TO LIST ALL CALLS MADE ON ONE DAY"
1920 PRINT"      ENTER THE DAY OF THE MONTH YOU"
1930 INPUT"      WOULD LIKE TO SEE";D
1935 LPRINT:LPRINT:LPRINT:LPRINT:LPRINT
1940 CLS:Q=0:R=0
1945 LPRINT TAB(20)" LIST OF ALL CALLS MADE ON ONE DAY"
1950 GOSUB 3000
1960 FOR I = 1 TO P1
1970 IF D=D(I) GOSUB 4000
1974 IF D=D(I) THEN Q=Q+C(I)
1978 IF D=D(I) THEN R=R+M(I)
1980 NEXT I
1985 LPRINT TAB(20)"TOTALS";TAB(40)R;TAB(48) USING"###.##";Q
1990 PRINT:PRINT
2000 PRINT"      DO YOU HAVE ANOTHER DATE TO ENTER"
2010 INPUT"            YES    OR    NO";G$
2020 IF G$="YES" GOTO 1900 ELSE GOTO 130
3000 LPRINT:LPRINT:LPRINT TAB(10)"DAY";TAB(38)"NUMBER";TAB(48)"COST"
3010 LPRINT TAB(10)"OF";TAB(16)"AREA";TAB(41)"OF";TAB(49)"OF"
3020 LPRINT TAB(9)"MONTH";TAB(16)"CODE";TAB(21)"EXCHANGE";TAB(30)"NUMBER";TAB(39)
"MINS";TAB(48)"CALL"
3030 LPRINT"-------------------------------------------------------------"
3040 RETURN
4000 LPRINT TAB(10)D(I);TAB(17)A(I);TAB(23)E(I);TAB(30)N(I);TAB(40)M(I);TAB(48) U
SING "###.##";C(I)
4010 RETURN
```

the three tables provided.

Table 1 shows that savings can be effected by renting a WATS line for areas covered by examples 1 and 2; however, it would not be of any benefit to rent one for example 3 since it would be more expensive than the directly dialed calls.

By using Table 2 we see that a savings could be made by renting a foreign exchange line for the exchanges covered by example 2, but renting lines covering exchanges in examples 1 and 3 would result in a higher cost. You should take into consideration the ability to accept incoming calls from the exchanges covered by a foreign exchange line and any benefit gained should also be taken into consideration.

Using Table 3, you can see that a savings can be made by installing a tie-line to 717-555-0111, 803-555-1616 and 609-766-2330, while it would be more expensive to rent a tie-line for 717-555-1215. Remember that the cost of toll calls must be the total number of calls going to and coming from the number.

The Program

The program is a TRS-80 Level II application, designed to hold one month's data in 16K. Lines 10 through 240 initialize the program and print the menu. If you ever want to change the program, keep in mind that the branches from the menu to the various parts of the program do not follow in order. For instance, function 3 branches to line 550 of the program, while function 2 branches to line 1600.

Starting with line 300, each block of program lines serves the function as called for by the ON-GOTO statement at line 230. The subroutine at 3000 prints the headings, and the subroutine at 4000 prints the data.

Using the Program

The program has been de-

	Example 1 Areas Covered	Cost	Example 2 Areas Covered	Cost	Example 3 Areas Covered	Cost
	215	278.56	201	101.12	201	101.12
	717	212.28	212	97.64	202	12.16
			301	93.20	203	9.23
			302	112.14	212	97.64
			315	88.99	216	-0-
			516	109.09	301	93.20
			518	124.16	302	112.14
			607	99.80	315	88.99
			609	89.89	413	17.37
			914	97.76	516	109.09
					518	124.16
					603	12.12
					607	99.80
					609	89.89
					716	4.34
					914	97.76
Total cost of toll calls		490.84		1,013.79		1,069.01
WATS line cost		400.00		700.00		1,200.00
Savings by WATS		90.84		313.79		(130.99)

Table 1.

	Example 1 Exchange Covered	Cost	Example 2 Exchange Covered	Cost	Example 3 Exchange Covered	Cost
	111	13.88	220	34.55	331	43.12
	112	12.12	221	37.37	332	43.34
	113	14.02	222	40.12	333	41.41
	114	13.73	223	35.09	334	17.36
	115	13.97	224	34.34	335	54.19
	116	14.04	225	41.41	336	47.72
	117	11.97	226	37.87		
			227	36.54		
			228	31.19		
Total cost of calls		93.73		328.48		247.14
Cost of foreign exchange line		120.00		190.00		400.00
Savings		(26.27)		138.48		(152.86)

Table 2.

Number	Cost of Toll Calls	Cost of Tie-line	Savings
717-555-0111	273.12	240.00	33.12
717-555-1215	208.71	312.00	(103.29)
803-555-1616	416.97	355.00	61.97
609-766-2330	303.16	237.00	66.16

Table 3.

Reader Service—see page 227

signed to analyze one month's data at a time. This is because that period is the telephone company's billing cycle. All toll calls and line rentals are billed on a monthly basis.

Using function 1, all necessary data is entered by responding to the various prompts. All other functions then perform on the data entered by this function.

Corrections are made using function 2. All data for a specific call is displayed as it is recorded on the file. The user is then prompted through the various call elements and given the chance to correct any errors. The correct call is then again displayed in order to see that the corrections were made properly.

Functions 3, 4 and 5 list the calls in various formats that allow comparison with the telephone company's reduced rate distance lines. Function 3 prints all calls into an area code and is used to make the WATS line comparison. Function 4 lists all calls to one exchange within an area code and is used for the foreign exchange line comparison. The data for making the tie-line comparison is provided by function 5.

Function 6, which lists all calls made on one day, is not used for a direct comparison of reduced rate lines, but merely provides a tool for the user to further analyze his telephone needs. Functions 7 and 8 are provided to save and enter a month's data using a cassette file.

When comparing the data provided with the telephone company rates, several months' results should be considered before a definite decision is made. This is required to ensure that the savings will be of a permanent nature. See the output of the various functions in the sample run.

Conclusion

There are almost as many uses for microcomputers as there are microcomputers. Some are pure entertainment, while others are directed at reducing costs and increasing profits. Few of these uses in the last category produce such instant and positive results and the reduction in telephone costs that can be attained using the TRS-80 and this program. ■

Sample run.

Function 1

Day of Month	Area Code	Exchange	Number	Number of Minutes	Cost of Call
1	717	716	3362	4	1.12
1	717	373	7878	8	3.12
1	717	716	3362	1	.98
2	717	373	7878	17	4.12
2	707	555	1213	1	.87
2	717	716	3362	3	1.28
3	717	716	3362	12	3.74
3	707	808	1212	16	12.29
3	707	373	7878	8	3.08

Function 3

Day of Month	Area Code	Exchange	Number	Number of Mins	Cost of Call
1	717	716	3362	4	1.12
1	717	373	7878	8	3.12
1	717	716	3362	1	0.98
2	717	373	7878	17	4.12
2	717	716	3362	3	1.28
3	717	716	3362	12	3.74
		TOTALS		45	14.36

Function 4

Day of Month	Area Code	Exchange	Number	Number of Minutes	Cost of Call
1	717	716	3362	4	1.12
1	717	716	3362	1	0.98
2	717	716	3362	3	1.28
3	717	716	3362	12	3.74
		TOTALS		20	7.12

Function 5

Day of Month	Area Code	Exchange	Number	Number of Mins	Cost of Call
1	717	373	7878	8	3.12
2	717	373	7878	17	4.12
		TOTALS		25	7.24

Function 6

Day of Month	Area Code	Exchange	Number	Number of Minutes	Cost of Call
2	717	373	7878	17	4.12
2	707	555	1213	1	0.87
2	717	716	3362	3	1.28
		TOTALS		21	6.27


MCD
SELECTRA
PRINT

✓ Reader Service—see page 227

Keyed-up PET

You "old PET" users can add a keyboard to your PET for less than $60.

Timothy L. Bramblet
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How many times have you wished that your PET had a bigger keyboard? This problem appeared to me in reverse. I can get along just fine on the PET keyboard, but while typing on a typewriter or another computer, I continually hit the wrong keys. I added a keyboard that plugs into the side of my PET. Either keyboard can be used, and it only cost me $25 to add a keyboard.

First, you need an unencoded keyboard. Many keyboards and kits are equipped with circuitry that puts out the appropriate ASCII code for the key selected. This is not what you want. The PET keyboard consists simply of switches. When you push a key, you short out two wires. The PET sees this and figures out what key you selected. Commodore must have had a lot of calculator keys left over and figured here was a place to get rid of them.

A new keyboard should not cost more than $30. Jameco Electronics has them advertised for $29.95 (see their ad in *Microcomputing*, March 1979, p. 166). I found mine in a computer store for $25. Surplus electronic stores are a good source for used ones, which quite often will still be mounted in a case.

Computer keyboards have the normal typewriter configuration plus extra keys for special purposes. The PET keyboard has the numbers and punctuation on separate keys, making it impossible to combine them on the upper row of keys as most keyboards have. I assigned each key the value of the lowercase symbol painted on it and used the extra keys for special punctuation and commands. For instance, the "here is" key is assigned RETURN; the "repeat" key is assigned =. I suggest that you decide what each key will be assigned and then label each of them on the back of the keyboard so there is no mix-up when you start wiring it.

Inside the PET

Opening the PET is easy. Remove the four screws under the front (two on each side), and the whole top of the PET swings up like the hood of a car. Tucked up in the back-left corner is a convenient little brace that swings down, fits into one of the screw holes and holds up the top.

Notice the 18 wires that run from the keyboard to a 20-pin in-line plug on the main logic board. The connections are labeled on the board A through H and 1 through 10. If the PET sees a connection between A and 7, it will print a Z . . . between H and 3, it will print a 9. This is what the PET keyboard does and what you are going to do with your external keyboard. Fig. 1 shows the cross connections for all of the unshifted characters. F-2, 4, 6, 8 and 10 are not used.

Construction

I attached my keyboard to the internal keyboard printed circuit board by means of a connector added to the left side of the PET.

Internal view showing added wiring (note speaker for internal sound).

	A	B	C	D	E	F	G	H
1	!	#	%	&	(	←	home	⇆
2	"	$	'	\	)		↑↓	del
3	Q	E	T	U	O	↑	7	9
4	W	R	Y	I	P		8	/
5	A	D	G	J	L	ret	4	6
6	S	F	H	K	:		5	•
7	Z	C	B	M	;	ret	1	3
8	X	V	N	,	?		2	+
9	shift	@	]	space	>	shift	0	–
10	rvs	[	space	<	stop		.	=

Fig. 1. Cross connections for all unshifted characters.

This was the neatest and easiest way to do it. I did not want to splice into the wire run or solder directly to the main logic board. If you ever have to remove the main board for servicing, you don't want to unsolder a bunch of wires to do it.

Remove eight small Phillips screws (four on top and four on bottom), and the whole keyboard assembly—numeric pad and all—will come out in one piece. Unplug it from the main board (carefully), and the unit will be free for easy soldering.

If the idea of drilling a hole in the side of your computer makes you sick, then attach the socket on ribbon cable routed between the upper and lower half through the front of the PET and let it dangle. My PET gets hauled around a lot, so I consider a mounted socket a necessity; neither does it look like an add-on.

Any 18-pin or more socket and plug will work. I used the 25-pin subminiature plug and socket as shown in the Jameco advertisement.

Before you start drilling and filing, remove the main logic board to protect it from metal filings. It is held in by three screws and three plastic clips. Everything unplugs from it, and it removes quite easily.

The display and recorder can be protected by pulling a plastic garbage bag over the entire top and taping it to the inside back. A small sack can be taped over the power supply. Do not let your family see the PET at this time, or you will spend a lot of time assuring them that the patient will live. Vacuum out the PET well when done. Even one small metal filing bridging two runs or between two chip pins can have interesting results.

Solder 18 wires between the socket and the connections on the upper-left corner of the internal keyboard. Be careful not to bridge the gaps, and use a low-wattage soldering iron. Make sure the wires are long enough to reach with the top up. These connections are not labeled, so remember that, starting on the left, they are A-H and 1-10. Use color-coded wires so you can keep track of this and still have everything in order by the time you get to the external keyboard.

If you know what each key is assigned and which wire is A, B, etc., then wiring the external keyboard should not be difficult. Start with wire A and solder it to one of the pins on key !, then key " and Q, etc. After you have wired up wires A through H, start with wire 1 and solder it to the other pin on key !, then key # and %, etc., until wires 1 through 10 are connected (see Fig. 1). Every key should have two wires connected to it when you are finished. One should be a letter and the other should be a number.

The PET has two shift keys and two space keys; beneath the return button are two return keys. In Fig. 1 you'll see that space is represented at 9-D and also at 10-C. Shift and return are also represented at two places. The PET will recognize either one. Don't wire (as a friend of mine did) 9-D and 10-C up to the same space key. It doesn't work. Just wire one space location (9-D or 10-C) to one space key. It doesn't matter which. The same goes for return and shift, although you will probably have two shift keys, then you can wire 9-F up to one shift key and 9-A up to the other.

The Case

Before a friend gave me a metal case for the keyboard, I had a problem with organizing the wires leaving it. On one end there is about one inch of plastic overhang. I drilled 18 small holes and stuck my wires through these, then held the whole thing in place with silicon rubber. I also placed a blob of silicon rubber in each corner to act as feet. A tube of silicon rubber is convenient to have in any construction project. My keyboard is glued into its case with silicon rubber.

Wire the plug to match the socket, thoroughly clean the PET, plug everything back in and test it. Any errors should be obvious and easily corrected.

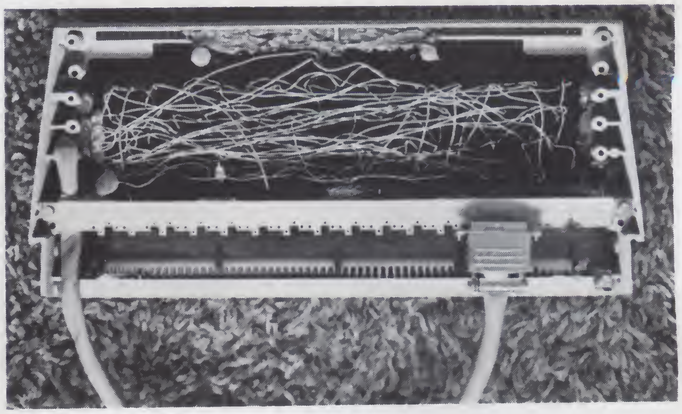
My keyboard case has two switches on it. I wired one across the shift so I could lock the shift on. I am still trying to find a good use for the other switch.

Since my junk box supplied the wire and connectors, this project only cost me $25. Had I bought everything, the cost still would not have exceeded $40. If you are going to make your own case, I suggest adding a keypad, which would free your numbers row for punctuation.

I have not experienced any key bounce with the external keyboard. The PET must have debounce circuitry inside and take care of that for us.

My keyboard works well and is a real pleasure to operate. It can be plugged in or out of the PET with the power on. I have noticed that TV interference goes up slightly with the keyboard plugged in, but only if the unit is close to the TV. ■

Internal keyboard detached to show how external keyboard is wired to it.



Underside of external keyboard (note silicon rubber holding the keyboard in case).

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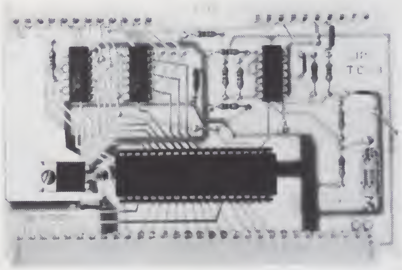

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Single-Drive Diskette Copier

Last month: breakpoints for North Star's monitor. This month: a copier for the Horizon-1.

No experienced designer will dispute the critical importance of creating frequent backups of software and data files. But in a small, single-drive system such as my 16K North Star Horizon-1, there is a sudden and acute temptation to skip this step as soon as a file becomes too large to save and restore in one step through memory. In the case of the Horizon, I suddenly found that instead of referencing a named file, I was calculating absolute disk addresses to step through the file in blocks that would fit in the available memory while the diskette was changed.

In the first place, this is for the birds. More important, it's dangerous. A miscalculation, an inadvertently skipped diskette change or any of several easily committed sins will result in the loss of not only the backup, but the original data as well.

```
 >OS
*GO DSKCPY
FROM DISK ? 11-TEXT

INSERT 11-TEXT
TO DISK ? 3-TXBKP

FROM FILE (C/R FOR WHOLE DISK) ? COPIER

TO FILE ? (C/R FOR SAME) ?

INSERT 3-TXBKP
INSERT 11-TEXT
INSERT 3-TXBKP

*
?
*
?
*GO DSKCPY
?
*GO DSKCPY
FROM DISK ? 11-TEXT

INSERT 11-TEXT
INSERT 11-TEXT
INSERT 11-TEXT
TO DISK ? 3-TXBKP

FROM FILE (C/R FOR WHOLE DISK) ? COPIER

TO FILE ? (C/R FOR SAME) ? NEWCOPY

INSERT 3-TXBKP
NEW FILE !  ASSIGN TO END OF DISK ? Y
INSERT 11-TEXT
INSERT 3-TXBKP

*LI
3-TXBKP     0    4    0
EDITOR    130   16    1  2A00
PRINTER    14   16    1  2A00
DATEL      30  100    0
DOS         4   10    0
NEWCOPY   236   39    0
M5600     146   10    1  5600
BRKPNTR   156   40    0
COPIER    196   40    0
*
```

Example 1.

Software Solution

The answer is a modest piece of software. With the assistance of a simple utility, the messy and dangerous job of swapping diskettes while reading and writing becomes easy, simple and much less time-consuming.

In order for the procedure to work, it is necessary to assign unique names not only to files but to entire diskettes as well. This is accomplished by creating a four-block file as the first file on the diskette, with the name of the diskette, as described in the North Star DOS manual. In effect, this names the directory.

The operating procedure for the diskette copier is to first specify the diskettes involved ("from-disk" and "to-disk"), then the files involved ("from-file" and "to-file"). Once the diskette and file names are entered, the program takes over and not only prompts diskette changes but checks to ensure that the proper diskette is entered.

The program's ability to check and insist that the correct steps have been performed is absolutely vital. This generates a solid assurance that no silly mistake will destroy the hard-won accomplishments of that late session with the system.

Note that the program resides entirely in memory so that neither the source nor object disk need contain the copy program. In other words, if "from-disk" is not found on the drive, a prompt will be issued before looking any further.

Similarly, the program verifies the existence of both the source and object files and ensures that errors do not occur as a result of different file-size allocations on the two diskettes. If a long file is copied to a short file, the operator is warned and given the option to truncate the file or abort the run.

If the destination file is not found, the program will first warn the operator. Then if allowed to continue, it will create a new file of the given name at the end of the diskette. The length of the new file will be either the length of the source file or the remaining space on the diskette, if there is not enough room for the whole file. In this case, the operator is warned, just as when copying to an existing file.

Appropriate defaults are provided for the entry of a carriage return (null entry) when either file name is prompted. The example runs should serve to clarify details of operation.

The assembly listing shown is configured for a 16K North Star with the application program origin at 2A00. The upper limit is placed at 55F0 to protect a debugging monitor that resides from 5600 to 5FFF. This can be changed by changing the EQU at the beginning of the program (HICOR). The more memory made available, the more will be loaded in one disk insertion, and the faster the operation will proceed.

For those who wish to adapt the program to another vendor's DOS, the entry points and functions used are documented at the top of the listing. ■

Program listing.

```
                      **           REVISED 24JUN79
                              ORG    :2A00
                      HICOR   EQU    :55FF
                      STKBEG  EQU    HICOR-:100
                      **
                      **    DOS ENTRY POINTS/ FUNCTIONS/ REGISTERS
                      **
                      **    :200D    CHARACTER OUTPUT
                      **               CHARACTER SUPPLIED IN B
                      **               DEVICE # SUPPLIED IN A
                      **               CHARACTER RETURNED IN A
                      **    :2010    CHARACTER IS INPUT TO A
                      **               DEVICE NUMBER SUPPLIED IN A ON ENTRY
                      **    :2019    DIRECTORY LOOKUP
                      **               DISK UNIT SUPPLIED IN A
                      **                   (1 FOR SINGLE DRIVE)
                      **               POINTER TO FILE NAME SUPPLIED IN HL
                      **               RETURN W/ CARRY SET
                      **                       INDICATES NOT FOUND
                      **                IN WHICH CASE FIRST FREE SECTOR IS
                      **                            IN HL
                      **               ON SUCCESS HL POINTS TO 8TH BYTE
                      **                           OF DIR ENTRY
                      **                   (WHICH IS STORED INSIDE DOS)
                      **    :201C    WRITES DIRECTORY ENTRY BACK.
                      **               IS USED ONLY AFTER :2019
                      **                AND MODIFICATION OF ENTRY IN CORE
                      **    :2022    DISK READ OR WRITE
                      **               # BLOCKS SUPPLIED IN A
                      **               READ (1) OR WRITE (0) SUPPLIED IN B
                      **               UNIT NUMBER SUPPLIED IN C
                      **                   (ALWAYS 1 FOR SINGLE)
                      **               START OF BUFFER SUPPLIED IN DE
                      **               DISK SECTOR SUPPLIED IN HL
                      **
                      **       DIRECTORY ENTRY FORMAT:
                      **
                      **          OFFSET 0-7     FILE NAME
                      **                 8-9     SECTOR NUMBER
                      **               10-11     LENGTH IN SECTORS
                      **               12-15     SPECIAL FILE TYPE DATA
                      **
2A00 31FF55                   LXI    SP,HICOR
2A03 210426                   LXI    H,BUFLEN
2A06 010001                   LXI    B,256
2A09 110000                   LXI    D,0
2A0C B7                       RSC
2A0D ED42       $ BFLNLP      DSC    B           COMPUTE BLKS IN BUFR
2A0F 13                       INX    D
2A10 F20D2A                   JP     BFLNLP
2A13 1B                       DCX    D
2A14 ED53F92E $               SDED   BFBLKS
2A18 21632D       GETFD       LXI    H,FD        PROMPT SOURCE DISK
2A1B 010C00                   LXI    B,TD-FD
2A1E CDBB2C                   CALL   OUTL
2A21 21B52D                   LXI    H,FDNM
2A24 010800                   LXI    B,8
2A27 CDC52C                   CALL   INL
2A2A 79                       MOV    A,C
2A2B FE08                     CPI    8
2A2D 28E9       $             BZ     GETFD
2A2F CD032D                   CALL   CLRBUF
2A32 21B52D                   LXI    H,FDNM
2A35 CD102D                   CALL   CHKDSK      MOUNT SOURCE DISK (IF NOT UP
2A38 216F2D       GETTD       LXI    H,TD        PROMPT DEST DISK
2A3B 010A00                   LXI    B,FF-TD
2A3E CDBB2C                   CALL   OUTL
2A41 21BE2D                   LXI    H,TDNM
2A44 010800                   LXI    B,8
2A47 CDC52C                   CALL   INL
2A4A 79                       MOV    A,C
2A4B FE08                     CPI    8
2A4D 28E        $             BZ     GETTD
2A4F CD032D                   CALL   CLRBUF
2A52 21792D       GETFF       LXI    H,FF        PROMPT SOURCE FILE
2A55 012100                   LXI    B,TF-FF
2A58 CDBB2C                   CALL   OUTL
2A5B 21C72D                   LXI    H,FFNM
2A5E 010800                   LXI    B,8
2A61 CDC52C                   CALL   INL
2A64 79                       MOV    A,C
2A65 CD032D                   CALL   CLRBUF
2A68 FE08                     CPI    8
2A6A 2045       $             BNZ    GETTF
2A6C 210000                   LXI    H,0         WILL BE WHOLE DISK
2A6F 22D92E                   SHLD   SRCBEG
2A72 22DD2E                   SHLD   DSTBEG
2A75 215E01                   LXI    H,350       LEN OF DISK
2A78 22DB2E                   SHLD   SRCLEN
2A7B 22DF2E                   SHLD   DSTLEN
2A7E 21E12E                   LXI    H,WDWARN    WARN OPERATOR
2A81 ED4BF72E $               LBCD   WDWL
2A85 CDBB2C                   CALL   OUTL
2A88 CD1020                   CALL   :2010       GET Y-N
2A8B 47                       MOV    B,A
2A8C AF                       XRA    A
2A8D CD0D20                   CALL   :200D       ECHO IT
2A90 F680                     ORI    :80
2A92 FED9                     CPI    'Y'
2A94 C20A2D                   JNZ    ENDJOB
```


Reader Service—see page 227

```
2A97 CDF62C                  CALL  CRLF
2A9A CD6C2C                  CALL  RDDSK     GET BUFR FROM 0
2A9D 21BE2D                  LXI   H,TDNM
2AA0 CD102D                  CALL  CHKDSK    PUT UP DEST DISK
2AA3 21D92D                  LXI   H,DIRBUF
2AA6 11FB2E                  LXI   D,BUFR
2AA9 010800                  LXI   B,8
2AAC EDB0       $            MW+R            SRC DIR/DEST NAME
2AAE C34C2C                  JMP   CPYRTN    START COPY
2AB1 219A2D        GETTF     LXI   H,TF      PROMPT DEST FILE
2AB4 011B00                  LXI   B,FDNM-TF
2AB7 CDBB2C                  CALL  OUTL
2ABA 21D02D                  LXI   H,TFNM
2ABD 010800                  LXI   B,8
2AC0 CDC52C                  CALL  INL
2AC3 79                      MOV   A,C
2AC4 FE08                    CPI   8
2AC6 200D       $            BNZ   CLRTF
2AC8 21C72D                  LXI   H,FFNM
2ACB 11D02D                  LXI   D,TFNM
2ACE 010800                  LXI   B,8
2AD1 EDB0       $            MW+R
2AD3 1803       $            BRA   SETUP
2AD5 CD032D        CLRTF     CALL  CLRBUF
2AD8 3E01          SETUP     MVI   A,1       UNIT 1
2ADA 21C72D                  LXI   H,FFNM
2ADD CD1C20                  CALL  :201C
2AE0 D2072B                  JNC   FFFND
2AE3 CDF62C                  CALL  CRLF
2AE6 21C72D                  LXI   H,FFNM
2AE9 010800                  LXI   B,8
2AEC CDBB2C                  CALL  OUTL
2AEF 21FB2A                  LXI   H,NFMESS
2AF2 010B00                  LXI   B,NFMSGL
2AF5 CDBB2C                  CALL  OUTL
2AF8 C30A2D                  JMP   ENDJOB
2AFB A0CECFD4      NFMESS    ASC   ' NOT FOUND '
2B06 00            NFMSE     DATA  0
                   NFMSGL    EQU   NFMSE-NFMESS
2B07 010400        FFFND     LXI   B,4
2B0A 11D92E                  LXI   D,SRCBEG
2B0D EDB0       $            MW+R
2B0F 010400                  LXI   B,4       GET TYP
2B12 115D2D                  LXI   D,SRCTYP
2B15 EDB0       $            MW+R
2B17 CD6C2C                  CALL  RDDSK
2B1A 21BE2D                  LXI   H,TDNM
2B1D CD102D                  CALL  CHKDSK    PUT UP DEST DISK
2B20 3E01                    MVI   A,1
2B22 21D02D                  LXI   H,TFNM
2B25 CD1C20                  CALL  :201C
2B28 D2E22B                  JNC   MOVDIR
2B2B 22DD2E                  SHLD  DSTBEG    STORE FOR FILE START
2B2E 218A2B                  LXI   H,NEWMSG
2B31 012400                  LXI   B,NEWMSL
2B34 CDBB2C                  CALL  OUTL      WARN OPERATOR-NEW FILE!
2B37 CD1020                  CALL  :2010
2B3A 47                      MOV   B,A
2B3B AF                      XRA   A
2B3C CD0D20                  CALL  :200D
2B3F F680                    ORI   :80
2B41 FED9                    CPI   'Y'
2B43 C20A2D                  JNZ   ENDJOB
2B46 CDF62C                  CALL  CRLF
2B49 2AF92E                  LHLD  BFBLKS
2B4C ED5BDB2E   $            LDED  SRCLEN
2B50 19                      DAD   D         TOTAL LEN
2B51 EB                      XCHG            IN DE
2B52 ED53DF2E   $            SDED  DSTLEN    STORE LEN
2B56 2ADD2E                  LHLD  DSTBEG
2B59 19                      DAD   D         HI ADDR IN HL
2B5A 115D01                  LXI   D,349
2B5D B7                      RSC
2B5E ED52       $            DSC   D
2B60 FA732B                  JM    NEWENT
2B63 215D01                  LXI   H,349
2B66 ED5BDD2E   $            LDED  DSTBEG
2B6A B7                      RSC
2B6B ED52       $            DSC   D
2B6D 22DF2E                  SHLD  DSTLEN
2B70 CD012C                  CALL  OVFLMS    OOPS!  TOO BIG
2B73 21CF2D        NEWENT    LXI   H,TFNM-1  POINT TO BLANK
2B76 3E01                    MVI   A,1
2B78 CD1C20                  CALL  :201C     FIND EMPTY ENTRY
2B7B D2C02B                  JNC   EMTFND
2B7E 21AF2B                  LXI   H,DIRFUL
2B81 011000                  LXI   B,DIRFL
2B84 CDBB2C                  CALL  OUTL
2B87 C30A2D                  JMP   ENDJOB
2B8A CEC5D7A0      NEWMSG    ASC   'NEW FILE !  ASSIGN TO END OF DISK ? '
2BAE 00            NEWMSE    DATA  0
                   NEWMSL    EQU   NEWMSE-NEWMSG
2BAF C4C9D2C5      DIRFUL    ASC   'DIRECTORY FULL !'
2BBF 00            DIRFE     DATA  0
                   DIRFL     EQU   DIRFE-DIRFUL
2BC0 010800        EMTFND    LXI   B,8
2BC3 B7                      RSC
2BC4 ED42       $            DSC   B
2BC6 EB                      XCHG
2BC7 21D02D                  LXI   H,TFNM
2BCA EDB0       $            MW+R            COPY IN NAME
```

```
2BCC 21DD2E                 LXI   H,DSTBEG
2BCF 010400                 LXI   B,4
2BD2 EDB0     $             MW+R              COPY START/LEN
2BD4 215D2D                 LXI   H,SRCTYP
2BD7 010400                 LXI   B,4
2BDA EDB0     $             MW+R
2BDC CD1F20                 CALL  :201F       UPDATE DIRECTORY
2BDF C34C2C                 JMP   CPYRTN
2BE2 11DD2E        MOVDIR   LXI   D,DSTBEG
2BE5 010400                 LXI   B,4
2BE8 EDB0     $             MW+R
2BEA 2ADB2E                 LHLD  SRCLEN
2BED ED5BF92E $             LDED  BFBLKS
2BF1 19                     DAD   D
2BF2 EB                     XCHG
2BF3 ED5BDF2E $             LDED  DSTLEN
2BF7 EB                     XCHG
2BF8 B7                     RSC
2BF9 ED52     $             DSC   D
2BFB FC012C                 CM    OVFLMS
2BFE C34C2C                 JMP   CPYRTN
2C01 2ADF2E        OVFLMS   LHLD  DSTLEN
2C04 22DB2E                 SHLD  SRCLEN
2C07 ED5BF92E $             LDED  BFBLKS
2C0B EB                     XCHG              BUFR LEN IN HL
2C0C B7                     RSC               DEST LEN IN DE
2C0D ED52     $             DSC   D           0 OR NEG IS OK
2C0F 2807     $             BZ    OVBFOK
2C11 FA182C                 JM    OVBFOK
2C14 ED53F92E $             SDED  BFBLKS
2C18 21322C        OVBFOK   LXI   H,OVMSG
2C1B 011900                 LXI   B,OVMSL
2C1E CDBB2C                 CALL  OUTL
2C21 AF                     XRA   A
2C22 CD1020                 CALL  :2010
2C25 47                     MOV   B,A
2C26 AF                     XRA   A
2C27 CD0D20                 CALL  :200D
2C2A F680                   ORI   :80
2C2C FED9                   CPI   'Y'
2C2E C20A2D                 JNZ   ENDJOB
2C31 C9                     RET
2C32 C6C9CCC5      OVMSG    ASC   'FILE OVFLO -- TRUNCATE ? '
2C4B 00            OVMSE    DATA  0
                   OVMSL    EQU   OVMSE-OVMSG
                   *
                   *  CPYRTN STARTS WITH WRITE
                   *   (FIRST BUFR ASSUMED LOADED)
                   *  THEN CHANGES DISKS AND READS
                   *  THEN CHANGES DISKS AND WRITES
                   *    ETC. UNTIL DONE
                   *
2C4C 21BE2D        CPYRTN   LXI   H,TDNM
2C4F CD102D                 CALL  CHKDSK
2C52 CD9F2C                 CALL  WRTDSK
2C55 2ADB2E                 LHLD  SRCLEN
2C58 010000                 LXI   B,0
2C5B B7                     RSC
2C5C ED42     $             DSC   B
2C5E CA0A2D                 JZ    ENDJOB
2C61 21B52D                 LXI   H,FDNM
2C64 CD102D                 CALL  CHKDSK
2C67 CD6C2C                 CALL  RDDSK
2C6A 18E0     $             BRA   CPYRTN
2C6C 2ADB2E        RDDSK    LHLD  SRCLEN
2C6F ED4BF92E $             LBCD  BFBLKS
2C73 B7                     RSC
2C74 ED42     $             DSC   B
2C76 F2842C                 JP    READIN
2C79 ED4BDB2E $             LBCD  SRCLEN      SHRT BLK AT END
2C7D ED43F92E $             SBCD  BFBLKS
2C81 210000                 LXI   H,0
2C84 22DB2E        READIN   SHLD  SRCLEN      UPDATE LEN
2C87 2AD92E                 LHLD  SRCBEG
2C8A 09                     DAD   B
2C8B ED5BD92E $             LDED  SRCBEG      WILL NEED OLD START FOR THIS
2C8F 22D92E                 SHLD  SRCBEG      AND START
2C92 EB                     XCHG              STRT DSK ADDR FOR THIS READ
2C93 11FB2E                 LXI   D,BUFR      RAM ADDR TO DE
2C96 79                     MOV   A,C         # BLKS
2C97 0E01                   MVI   C,1         UNIT 1
2C99 0601                   MVI   B,1         READ
2C9B CD2220                 CALL  :2022
2C9E C9                     RET
2C9F ED5BDD2E $ WRTDSK      LDED  DSTBEG
2CA3 2AF92E                 LHLD  BFBLKS
2CA6 19                     DAD   D
2CA7 22DD2E                 SHLD  DSTBEG      UPDATE DEST ADDR
2CAA EB                     XCHG              DSK ADDR TO HL
2CAB 11FB2E                 LXI   D,BUFR      RAM ADDR TO DE
2CAE ED4BF92E $             LBCD  BFBLKS
2CB2 79                     MOV   A,C         # BLOCKS
2CB3 0E01                   MVI   C,1         UNIT 1
2CB5 0600                   MVI   B,0         WRITE
2CB7 CD2220                 CALL  :2022
2CBA C9                     RET
                    *
                    *     STRING IO ROUTINES
                    *  START OF STRING IN HL
                    *  LENGTH IN BC
                    *  DISPLAYS STRING, THEN RETURNS
```


Reader Service—see page 227

```
2CBB AF               OUTL    XRA   A
2CBC 46                       MOV   B,M
2CBD CD0D20                   CALL  :200D
2CC0 0D                       DCR   C
2CC1 C8                       RZ
2CC2 23                       INX   H
2CC3 18F6        $            BRA   OUTL
                      * START OF BUFR IN HL
                      * MAX LEN IN BC
                      * STOPS ON C/R
                      * LEFT ARROW TO DEL LAST CHAR
2CC5 79               INL     MOV   A,C
2CC6 32F42C                   STA   INLEN
2CC9 AF               INLP    XRA   A
2CCA CD1020                   CALL  :2010       DOS INP RTN
2CCD 77                       MOV   M,A
2CCE 47                       MOV   B,A
2CCF AF                       XRA   A
2CD0 CD0D20                   CALL  :200D
2CD3 FE0D                     CPI   :0D         CR -- QUIT
2CD5 2819        $            BEQ   INEXIT
2CD7 FE08                     CPI   :08         BSP ??
2CD9 200A        $            BNZ   INLNXT
2CDB 3AF42C                   LDA   INLEN
2CDE B9                       CMP   C           AT START -- IGNORE BSP
2CDF 28E8        $            BZ    INLP
2CE1 0C                       INR   C
2CE2 2B                       DCX   H
2CE3 18E4        $            BRA   INLP
2CE5 FE20             INLNXT  CPI   :20
2CE7 38E0        $            BLS   INLP        IGNORE CTL CHARS
2CE9 23                       INX   H
2CEA 0D                       DCR   C
2CEB CAF02C                   JZ    INEXIT
2CEE 18D9        $            BRA   INLP
2CF0 CDF62C           INEXIT  CALL  CRLF
2CF3 C9                       RET
2CF4 0000             INLEN   DBL   0
2CF6 060D             CRLF    MVI   B,:0D
2CF8 AF                       XRA   A
2CF9 CD0D20                   CALL  :200D
2CFC 060A                     MVI   B,:0A
2CFE AF                       XRA   A
2CFF CD0D20                   CALL  :200D
2D02 C9                       RET
2D03 0D               CLRBUF  DCR   C           CLEAR C BYTES FROM HL
2D04 F8                       RM
2D05 3620                     MVI   M,:20
2D07 23                       INX   H
2D08 18F9        $            BRA   CLRBUF
2D0A CDF62C           ENDJOB  CALL  CRLF
2D0D C32820                   JMP   :2028
                      *
                      * DISKETTE CHANGE RTN
                      * DESIRED DISK NAME POINTED BY HL
                      * READS BLK 0 TO CHK - RET WHEN OK
                      * NOT MOUNTED -- DSPLY MSG, WAIT FOR ANY KEY
2D10 225B2D           CHKDSK  SHLD  SAVNAM
2D13 3E01             CHKDS1  MVI   A,1         1 BLOCK
2D15 0601                     MVI   B,1         READ
2D17 0E01                     MVI   C,1         UNIT 1
2D19 11D92D                   LXI   D,DIRBUF
2D1C 210000                   LXI   H,0         DSK BLK 0
2D1F CD2220                   CALL  :2022
2D22 21D92D                   LXI   H,DIRBUF
2D25 0608                     MVI   B,8
2D27 DD2A5B2D    $            LXD   SAVNAM
2D2B DD7E00      $    CHKCHR  LAX   0
2D2E BE                       CMP   M
2D2F 2006        $            BNZ   CHKMSG
2D31 23                       INX   H
2D32 DD23        $            INX   X
2D34 10F5        $            DBNZ  CHKCHR
2D36 C9                       RET
2D37 21522D           CHKMSG  LXI   H,MSGDSK
2D3A ED4B592D    $            LBCD  MSGDL
2D3E CDBB2C                   CALL  OUTL
2D41 2A5B2D                   LHLD  SAVNAM
2D44 010800                   LXI   B,8
2D47 CDBB2C                   CALL  OUTL
2D4A CD1020                   CALL  :2010
2D4D CDF62C                   CALL  CRLF
2D50 18C1        $            BRA   CHKDS1
2D52 C9CED3C5         MSGDSK  ASC   'INSERT '
2D59 0700             MSGDL   DBL   MSGDL-MSGDSK
2D5B 0000             SAVNAM  DBL   0
2D5D                  SRCTYP  RES   4
2D61 0000             DBLWK   DBL   0
2D63 C6D2CFCD         FD      ASC   'FROM DISK ? '
2D6F D4CFA0C4         TD      ASC   'TO DISK ? '
2D79 C6D2CFCD         FF      ASC   'FROM FILE (C/R FOR WHOLE DISK) ? '
2D9A D4CFA0C6         TF      ASC   'TO FILE ? (C/R FOR SAME) ? '
2DB5                  FDNM    RES   8
2DBD 20                       DATA  :20
2DBE                  TDNM    RES   8
2DC6 20                       DATA  :20
2DC7                  FFNM    RES   8
2DCF 20                       DATA  :20
2DD0                  TFNM    RES   8
2DD8 20                       DATA  :20
2DD9                  DIRBUF  RES   256
```

```
2ED9 0000     SRCBEG  DBL    0
2EDB 0000     SRCLEN  DBL    0
2EDD 0000     DSTBEG  DBL    0
2EDF 0000     DSTLEN  DBL    0
2EE1 C3CFD0D9 WDWARN  ASC    'COPY ALL SECTORS ?!?! '
2EF7 1600     WDWL    DBL    WDWL-WDWARN
2EF9 0000     BFBLKS  DBL    00         PLUGGED AT STRT =BUFLEN/256
2EFB          BUFR    RES    STKBEG-BUFR
              BUFLEN  EQU    STKBEG-BUFR
54FF                  END

****************************
* S Y M B O L   T A B L E *
****************************

HICOR   55FF   BFLNLP 2A0D   GETFD   2A18   GETTD   2A38
GETFF   2A52   GETTF  2AB1   CLRTF   2AD5   SETUP   2AD8
NFMESS  2AFB   NFMSE  2B06   NFMSGL  000B   FFFND   2B07
NEWENT  2B73   NEWMSG 2B8A   NEWMSE  2BAE   NEWMSL  0024
DIRFUL  2BAF   DIRFE  2BBF   DIRFL   0010   EMTFND  2BC0
MOVDIR  2BE2   OVFLMS 2C01   OVBFOK  2C18   OVMSG   2C32
OVMSE   2C4B   OVMSL  0019   CPYRTN  2C4C   RDDSK   2C6C
READIN  2C84   STKBEG 54FF   OUTL    2CBB   INL     2CC5
INLP    2CC9   INLNXT 2CE5   INEXIT  2CF0   INLEN   2CF4
CRLF    2CF6   CLRBUF 2D03   ENDJOB  2D0A   CHKDSK  2D10
CHKDS1  2D13   CHKCHR 2D2B   CHKMSG  2D37   MSGDSK  2D52
MSGDL   2D59   SAVNAM 2D5B   SRCTYP  2D5D   DBLWK   2D61
FD      2D63   TD     2D6F   FF      2D79   TF      2D9A
FDNM    2DB5   TDNM   2DBE   FFNM    2DC7   TFNM    2DD0
DIRBUF  2DD9   SRCBEG 2ED9   SRCLEN  2EDB   DSTBEG  2EDD
DSTLEN  2EDF   WDWARN 2EE1   WDWL    2EF7   BFBLKS  2EF9
BUFR    2EFB   BUFLEN 2604   WRTDSK  2C9F
```

Reader Service—see page 227

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Cassette Quality Test

The "CONOPS" series continues with a program to test tape quality.

Micro-buffs need no reminder that our fascinating machines are capable of all kinds of little tricks that test our patience and intelligence. Some of these problems are caused by defective magnetic recording tape. Naturally, we must be prepared to discover that while a bad tape may be rare, it will most likely appear when we want to get a perfect recording of something irreplaceable and irretrievable.

This article describes a certain, but easy, method for testing a cassette to determine whether it is fit to use. The program listing shown is tailored to the Heath H8 computer, but can be adapted to run on any micro. It is assumed that H8 owners will be using CONOPS (see *Microcomputing*, July 1979, p. 108); if not, a few adjustments will be required.

Introduction

The inherent redundancy of the 300 baud Kansas City Standard cassette system makes it quite tolerant of minor tape defects, but tape quality becomes increasingly critical when you use higher baud rates. The Heath H8 cassette system uses the Kansas City Standard at 1200 baud, the maximum rate possible without loss of compatibility. The H8 cassette system is a gem, being fast and reliable, but it will fail, as will any other system, if the tape is faulty.

My experience has been that tape defects are not frequent, provided that you find a good brand and stick with it. U.S. manufacturers, on the whole, seem to do acceptable quality control of their cassettes. I learned early in the game that price is not an infallible guide to quality. For example, I have had good results with low-priced, C-30 Concertape cassettes from Radio Shack. On the other hand, two of a total of six purchased from Heath Company, at $2 each, were unreliable. Scelbi Computer Consulting (PO Box 133, PP Station, Dept. B, Milford CT 06460) sells high-quality, 10-minute cassettes at about $2 each. Microsette Co., 777 Palomar Ave., Sunnyvale CA 94086, has good ones at bargain prices. See their ads in *Microcomputing*.

Tape Test

The H8 tape-quality test consists of two programs that are independent, although they are shown in adjacent locations. The first, called DUMP, starts at 6000H. It puts a continuous string of test characters on the tape. The ASCII character, U, is used because, in binary, it appears as 01010101, and the entire length of tape becomes loaded with an unbroken row of alternating zero and one bits. You can start reading the tape anywhere and will get nothing but U's if the bit string is unimpaired. Simple idea, but it works.

When the end of the tape has been reached during the recording, you can hit the CANCEL key on the H8 front panel to stop the DUMP program and exit to the monitor. I find it convenient to write the test bits on both sides of the cassette and, thereby, avoid the need for rewinding.

When the tape is ready to be tested, enter the READ program at the address 601DH and start the tape moving. If the cassette-player volume-control setting is adjusted to give a lower than

Program listing.

```
                    * TAPE QUALITY TEST
                    *
                    * BY CHESNEY E. TWOMBLY
                    *     15 STORER ST.,
                    *   KENNEBUNK ME 04043
                    *
                    *     APRIL 19, 1979
                    *
                    *
                    * THIS PROGRAM FILLS A TAPE WITH ASCII CHARACTER, U .
                    * WHICH HAS A NICE ALTERNATING PATTERN, 01010101 B.
                    * TAPE IS THEN READ BY A SPECIAL PROGRAM WHICH DETECTS
                    * ANY ERROR AND SOUNDS HORN TO ALERT THE OPERATOR.
                    *
                           OPT    MEM,NUM
6000                       ORG    $6000
                    *
              6EDB  MONIT  EQU    $6EDB
6000 3E 01          DUMP   MVI    A,1      ;TURN ON TAPE
6002 D3 F9                 OUT    $F9      ;TAPE CONROL
6004 DB F0          WRITE  IN     $F0      ;PAD INPUT PORT
6006 FE 6F                 CPI    $6F      ;CHECK FOR CANCEL  *
6008 DB F9                 IN     $F9      ;GET TAPE STATUS
600A CA DB 6E              JZ     MONIT    ;EXIT
600D E6 01                 ANI    1        ;TRANSMITTER READY IF 1
600F CA 04 60              JZ     WRITE    ;NOT READY SO KEEP TRYING
6012 3E 11                 MVI    A,$11    ;BITS TO ENABLE TRANSMITTR
6014 D3 F9                 OUT    $F9      ;TURN ON TRANSMITTER
6016 3E 55                 MVI    A,$55    ;TEST CHARACTER 'U
6018 D3 F8                 OUT    $F8      ;WRITE TEST CHAR ON TAPE
601A C3 04 60              JMP    WRITE    ;KEEP ON WRITING
```

normal output, it will introduce a bias toward failure, which is desirable since we want to catch any marginal defect. The failure of any one bit to be read will result in an audible beep signal from the H8, and you can then stop the tape and jot down the tape-counter reading to document the location of the fault. Advance the tape to a point beyond the fault and then reenter the READ program to continue the test.

Some recording failures are due to mechanical binding in the cassette, which may cause speed irregularities of a degree that is beyond the maximum the system will tolerate. Any cassettes with that problem should be rejected, but be sure that the cassette-player drive system is not at fault. Slipping drive spindles or fluctuating line voltage are possible causes of erratic tape speed. Tapes having extreme thinness—often found in 60-minute and longer cassettes—are particularly prone to transport problems. The tape cassette is not a precision device, and we are fortunate to find so many that work OK.

I have found that cassette tape recorders tend to become unreliable with use, as a result of mechanical wear and dirty heads. Thus, it can happen that a tape that checks OK today may not run tomorrow. A good practice is to verify the condition of your recorder now and then by running a short test tape you know is reliable. A backup recorder is not a bad idea.

What got me started on this tape-test project was an advertisement in another magazine that offered 10-minute cassettes at a bargain price. When I examined the batch that was delivered, I began to doubt the quality of the tapes. They looked like factory rejects. I then came up with this scheme to check them out. The results were as follows:

Four passed the test 100 percent.

One was OK on one side—other side had a bad spot.

Four had an average of two bad spots on each side.

One was rejected for binding.

Conclusion

Those of you who try my tape-test procedure will find that the satisfaction of certifying the quality of your tapes is not without a price. The price is time. A 10-minute cassette requires 20 minutes plus overhead to check. My personal feeling is that the value received is well worth the cost. Even without the aggravation caused by imperfect recordings, there will be problems enough, and the market for aspirin should continue to do well. ■

```
                       *
                       * AFTER TAPE HAS BEEN PREPARED BY THE
                       * DUMP PROGRAM, REWIND AND ENTER THE
                       * READ PROGRAM, WHICH IS LISTED NEXT.
                       *
    601D 01 05 00  READ     LXI    B,$5       :SET UP COUNTER
    6020 3E 34     READ1    MVI    A,$34      :TURN ON READER
    6022 D3 F9              OUT    $F9        :TAPE CONTROL
    6024 DB F9     RR       IN     $F9        :GET TAPE STATUS BITS
    6026 E6 02              ANI    2          :READER READY IF 2
    6028 CA 24 60           JZ     RR         :READER NOT READY. TRY AGAIN
    602B DB F8              IN     $F8        :READ BYTE FROM TAPE
    602D FE 55              CPI    $55        :VERIFY THE BYTE JUST READ
    602F CA 20 60           JZ     READ1      :BYTE OK. GET NEXT
    6032 0D                 DCR    C          :DECREMENT CNTR
    6033 CA DB 6E           JZ     MONIT      :EXIT AFTER 5
    6036 CD 5E 02           CALL   $025E      :SOUND HORN
    6039 C3 20 60           JMP    READ1      :RESTART
                       *
                            END

    0 ERROR(S) DETECTED


SYMBOL TABLE:

DUMP    6000    MONIT  6EDB    READ    601D    READ1  6020    RR      6024
WRITE   6004



MOVE CODE?
```


✓ Reader Service—see page 227

1802 EPROM Programming

This design implements in-circuit programming for the COSMAC 1802 microprocessor.

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The erasable programmable read-only memory (EPROM) is a memory device that has become popular in many microprocessor applications. It offers protection of stored programs and data when power is turned off, and yet offers flexibility for making program design changes by erasing with ultraviolet light and reprogramming.

Recent developments in EPROMs have made great strides in increasing the capacity of the devices while reducing the power consumption. These developments have also resulted in features that make in-circuit programming more practical, eliminating the need for separate, off-line EPROM programming equipment.

This article discusses some of the issues involved in designing for in-circuit programming and verifying the 2048-byte 2716 EPROM, and presents a design for implementing in-circuit programming in a COSMAC 1802 microprocessor system.

Design Objectives

My primary objectives in this design bore significant influence on the design decisions I made, where more than one option was open to me. Foremost among my design objectives were:

- Low Power—this is in keeping with my selection of the COSMAC 1802 microprocessor in the first place. (I like the option of being able to operate from batteries.)
- Flexibility—under program control, I wanted to be able to switch from *program* sequence to *verify* sequence.
- In-circuit Programming—I wanted to be able to program the EPROM from the erased state without removing the component from its socket. Later, if I wish to implement a microprocessor-controlled ultraviolet (UV) erasing light, I may do so with the result that I will have complete microprocessor control over both the erasing and the programming of nonvolatile memory.

In keeping with the low-power constraint, I selected the Intel 2716. It should be noted here that while Intel and Texas Instruments (TI) both market a 2716, there are drastic differences between the two devices.

Intel's device requires only a single 5 volt supply in *read* mode, while TI's requires three supplies. Intel's device requires only TTL levels for the programming data inputs, with a TTL-level programming pulse applied to a separate pin while a constant 25 volt level is applied to yet another pin. The TI device also requires only TTL levels for the programming data inputs but, in addition, requires a shift of the +5 volt supply input to a +12 volt level before a 26 volt programming pulse is applied to a separate pin.

Most significant, the Intel device has a power-down mode that reduces the specified maximum 5 volt power drain from 105 mA (in the active *read* mode) to 30 mA (in the power-down mode). Specified *typical* 5 volt power drain in the power-down mode is 15 mA. This means I can probably support 65K bytes (thirty-two 2716s) of nonvolatile, alterable memory with less than 1 Amp of 5 volt power.

I fully recognized that in designing for in-circuit programming and program control of the *program/verify* sequence selection I would be adding to the component count (and hence the cost) of implementing the 2716 as a read-only memory device.

Isolation Is the Key

In order to permit the EPROM memory system to be programmed directly from the microprocessor, the memory address lines and the data lines of the EPROM memory system must be completely isolated from the microprocessor's main memory address bus and data bus, respectively. This isolation must be maintained while separate mechanisms provide the memory address and programming data during the programming sequence. An illustration of this functional arrangement is provided in Fig. 1.

In *normal* mode, when the microprocessor is using data or instructions previously stored in the EPROM, functional switches S2 and S1 provide conventional connections from the memory system to the data and address buses, respectively, of the microprocessor. In the *program* mode, however, these switches interrupt the conventional connections and provide, instead, connections to the outputs of latches.

These latches are loaded by the microprocessor in a manner that treats them as conventional output devices. The eleven-bit latch is treated by the 8-bit microprocessor as two separate latches (one 8-bit and one 4-bit latch).

Prior to entering the program sequence (in *program* mode), a microprocessor program must reside in some portion of (a separate) memory. This may be a section of random access read/write memory (RAM) or a separate 2716 EPROM that remains connected to the address bus and data bus in the conventional manner, without regard to the position of functional switches S1 and S2.

The microprocessor program must take two address bytes obtained from some source designated by the program (e.g., keyboard or paper tape) and load them into the 11-bit latch. The low-order 8 bits of address are loaded into the lower portion of the latch, and the high-order 3 bits of address are loaded into the upper portion of the latch.

The program must then take a byte of data from some source designated by the program (could be the same as, or a source different from, that for the address bytes) *and* load it into the 8-bit latch. This byte of

MODE	SEQUENCE	PD/PGM	$\overline{CS}$	V_{PP}	OUT	IN
NORMAL	READ	0(LOW)	0(LOW)	5V	DATA	
	POWER DOWN	1(HIGH)	X	5V	HI-Z	
	DESELECT	X	1(HIGH)	5V	HI-Z	
PROGRAM	PROGRAM	H-L 50mS pulse	1(HIGH)	25V		DATA
	VERIFY	0(LOW)	0(LOW)	25V	DATA	
	INHIBIT	0(LOW)	1(HIGH)	25V	HI-Z	

X = "DON'T CARE"

Table 1. Control signals for the 2716.

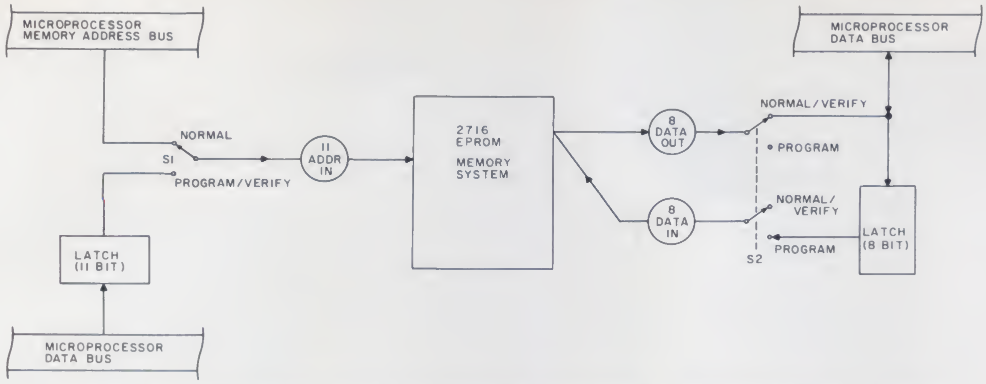

Fig. 1. A functional illustration of the isolation arrangement for address and data lines.

data represents the bit-pattern to be programmed into the 2716 address, which was previously loaded into the 11-bit latch.

Then Comes Programming

Now that we have the data and address lines set up for programming, what about the programming control? Three pins on the 2716 are involved in setting up and controlling the programming sequence. Table 1 illustrates the different conditions on each of these three pins for both the normal read sequence and the programming sequence.

In the *normal* mode, +5 volts is applied to pin 21 (Vpp) of the 2716. Also, the combination of signals on pin 18 (PD/PGM) and pin 20 ($\overline{CS}$) determines whether the 2716 (in a group of 2716s) is selected for "read" or not. There are alternative approaches to implementing these latter two signals. The approach selected may be dictated, in part, by the memory timing scheme of the microprocessor being used.

Considering the memory timing scheme of the 1802 at the speed mine is operating (2.66 MHz crystal), and in light of my low-power objective, I selected the following approach.

In the *normal* mode I'm not interested in the "Deselect" state; when not reading data out of the memory I want the memory to remain in the "power-down" state. I therefore maintain the $\overline{CS}$ signal low and the PD/PGM signal high, except during the read sequence. During the read sequence I drive the PD/PGM signal low only for the 2716 chip selected. All other 2716 chips remain in the power-down state.

By using this approach I pay a penalty of up to 330 nanoseconds in access time, but in my 1802 system this does not affect operation.

In the *program* mode, +25 volts is applied to pin 21 (Vpp) of the 2716. Again, the combination of signals on pin 18 (PD/PGM) and pin 20 ($\overline{CS}$) determines whether the 2716 (in a group of 2716s) is selected for "programming" or not.

Unfortunately, the active state of the PD/PGM signal in *program* mode is inverted from its active state in *normal* mode. That is, PD/PGM must be held *low* in the *program* mode, except during the interval (nominal 50 ms) during which the 2716 is selected for programming. (Remember: In *normal* mode I hold PD/PGM high to conserve power and drive it low to read.)

Also, $\overline{CS}$ must be held high during the programming sequence. Subsequently, to verify that the memory location was successfully programmed, both PD/PGM and $\overline{CS}$ must be low during the verify (read) sequence.

Fig. 2 provides a functional illustration of the implementation of the $\overline{CS}$ and PD/PGM control signals superimposed on Fig. 1. Fig. 3 shows the logic state relationships of this implementation.

When S1 (Fig. 2) is in the *normal* position, $\overline{CS}$ is held low. In Fig. 3, when $\overline{CS}$ is low, the A_2 input to N_2 is also low, maintaining J_2 high no matter what the state of the B_2 input. The output of inverter I_1 is held high with $\overline{CS}$ low, maintaining the A_1 input to N_1 high. This allows N_1 to act as an inverter for the B_1 input.

With "chip select" high, the output of G_1 then follows the output of N_1. The state of the C input to the exclusive OR is the same as the output of I_1, and with C high, K follows the state of the B_1 input to N_1. This acts to maintain PD/PGM in the high state except during the read sequence, thus conserving power.

When S1 is in the *program/verify* position, the state of $\overline{CS}$ is controlled by the state of the 12th bit of the latch, which is microprocessor-program controlled. Prior to initiating the programming sequence and while loading the data and address latches, the microprocessor program maintains the 12th bit of the latch in the low state.

After the data and address latches are loaded, the microprocessor program sets the 12th bit of the latch high and, within a few instruction times, initiates the program pulse (active low) to the B_2 input of N_2 (Fig. 3). With $\overline{CS}$ now high, the roles of N_1 and N_2 are reversed and J_1 is maintained high, independent of input B_1.

For the chip that is selected (through address decode) for programming, the output of G_1 now follows the output of N_2. Now, however, C is low and K follows the inverted state of the B_2 input to N_2. The microprocessor program controls the length of time that B_2 is held low and,

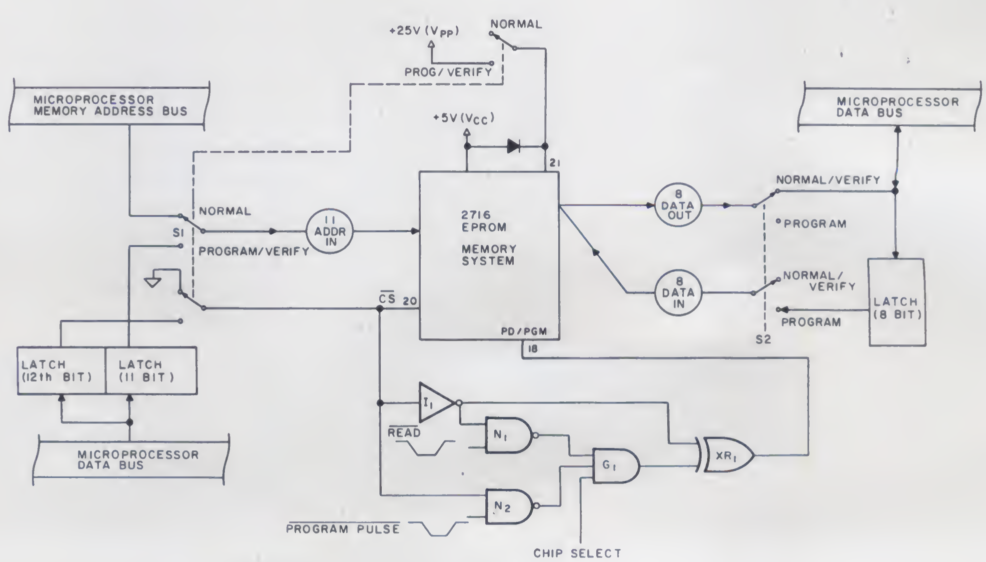

Fig. 2. A functional illustration of the control signal implementation.

after a nominal 50 milliseconds, returns B_2 to the high state (and K to the low state).

Now We Verify

Following the programming sequence just described, I want to verify that the intended programming of the current address was successful before advancing to the next address to be programmed. Note that the 2716 is now in the inhibit state in accordance with Table 1, with PD/PGM low and $\overline{CS}$ high.

While doing the design, I wondered what would happen if $\overline{CS}$ was switched back to the low state and PD/PGM was subsequently switched to the high state with Vpp held at 25 volts. I had noted that in the published specifications this condition was not accounted for, as can be seen in Table 1.

I posed this question to the Intel applications engineer; to my delight, he informed me that even with Vpp at 25 volts, as long as $\overline{CS}$ was held low, further programming could not take place, no matter what the state of PD/PGM.

With microprocessor-program control of $\overline{CS}$ through bit 12 of the latch, I can now switch $\overline{CS}$ low in preparation for verifying. When $\overline{CS}$ goes low, through the action of the gating arrangement as shown in Fig. 3, PD/PGM goes high approximately one-quarter to one-half microsecond later. The control signals $\overline{CS}$ and PD/PGM are now back in the same state as they would be in *normal* mode, with the B_1 input to N_1 controlling the read sequence.

But wait a minute! With switch S2 (Fig. 2) in the *program* position, the output data from the 2716 is not accessible to the microprocessor's data bus and, thus, can't be verified! As you'll see, I took care of that problem by controlling the position of the functional switch, S2, with the state of $\overline{CS}$. When $\overline{CS}$ is high, S2 is in the *program* position. When $\overline{CS}$ is low, S2 is in the *normal/verify* position.

Thus, after completing the programming sequence and switching $\overline{CS}$ low in preparation for verifying, a normal read sequence will make the data available for verifying by the microprocessor. Following the verify sequence, the microprocessor can proceed to setting the data and address for the next programming sequence (or repeat the sequence for the same data and address if the first attempt did not "take").

How's It Wired?

Fig. 4 gives a wiring diagram of my design to implement the isolation and control mechanisms shown functionally in Fig. 2. All of the logic chips, other than the 2716, are CMOS because of their low power requirements.

I might also point out that up to thirty two 2716s (for 65K bytes) could be connected in parallel on all pins except pin 18. Pin 18 (PD/PGM) on each 2716 must be connected to a unique exclusive OR gate, which, in turn, must have as one input the output from a unique three-input AND gate for unique chip selection. Otherwise, all logic shown is common to all 2716s.

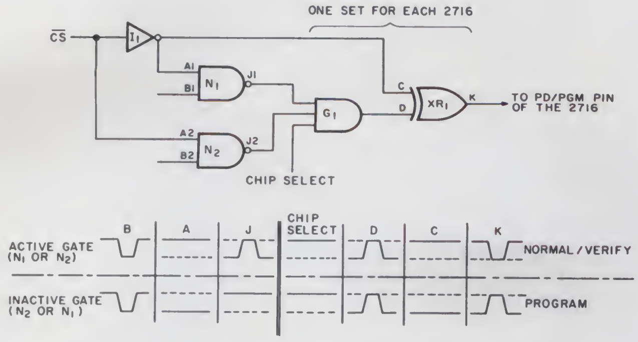

Fig. 3. Logic state relationships of the control signal implementation.

Pin numbers are not shown for the microprocessor's data bus and address bus, since for each particular case of anyone wishing to implement this design on his microprocessor, these will be different.

Also, in some cases, the particular microprocessor system may already provide 16 latched address lines. In such cases the 4042s that I used (Fig. 4) to latch address lines MA8 through MA15 may be eliminated.

In the 1802, the upper eight bits of address are multiplexed out on eight address lines, and a timing signal (TPA) is provided for latching these bits externally. The lower eight bits of address are then latched internally on the same eight address lines for the remainder of the machine cycle.

The 40097s (A, B, C and D) are three-state buffers which, together with S1 in Fig. 4, satisfy the functional requirement for S1 in Fig. 1. When S1 in Fig. 4 is in the *normal* position, 40097s A and B are enabled and 40097s C and D are disabled. This allows the memory address to be applied to the 2716 in the normal manner.

Note that this state also allows $\overline{CS}$ to be held low through the 22k resistor tied to pin 20 of the 2716 and +5 volts to be applied to pin 21 of the 2716 through the diode. The specified tolerance for Vpp (Vpp = Vcc ± .6 V) permits the diode drop in normal operation.

When S1 is in the *program* position, 40097s C and D are enabled and 40097s A and B are disabled. This allows the latched outputs of the three 40193s to be applied to the address inputs of the 2716.

Also, the state of $\overline{CS}$ is now controlled by the microprocessor-controlled state of bit 12 of the (40193) address latch. This signal is also applied to the enable inputs of 40097 E and one enable input ($\overline{E02}$) of 40097 F.

Before proceeding further I should explain that the 40097 is designed with two enable inputs: $\overline{E02}$ controls the (two) outputs on pins 11 and 13, and $\overline{E04}$ controls the (four) outputs on pins 3, 5, 7 and 9.

The inverter (I_1 in Fig. 3, 1/6 of a 4049 in Fig. 4) inverts $\overline{CS}$, and its output, in addition to its function in the control signal implementation, as explained using Fig. 3, is applied to the ($\overline{E04}$) enable inputs of 40097s G and F.

The 40097s E, F and G now operate as the functional equivalent of S2 in Fig. 2, with the "position" of S2 controlled by the microprocessor-controlled state of bit 12 of the 12-bit latch. When $\overline{CS}$ is low (in *normal* or when reading to verify), the data output lines of the 2716 are connected to the microprocessor data bus and the 8-bit latch (1852) outputs are disconnected from the 2716.

When $\overline{CS}$ is high (during the programming sequence), the data bus is disconnected and the 1852 latch outputs are connected to the data pins of the 2716.

The 1852 is an input/output port chip designed for use with the 1802. The TPB and $\overline{MRD}$ inputs are timing control signals supplied directly from the 1802 for output sequences. The $\overline{CLEAR}$ input is supplied from my 1802 system logic. The N = 6 input is a decoded "output device select" signal generated by an OUT (output) instruction with device code of N = 6. For another type of microprocessor, any simple equivalent output latch implementation will work. Timing of this latch's outputs is not critical.

It need not, by the way, be an output latch dedicated only to function in programming 2716s, provided any device sharing this output port can be disabled in some manner during programming mode. In fact, in my design both the 1852 and 12-bit latch made up of 40193s are multipurpose latches.

The 40193 is a 4-bit binary up/down counter with parallel-load inputs. When no "count" inputs are present, the counter can be loaded like any other output latch. The $\overline{\text{load enable}}$ for loading the latch from the microprocessor data bus is derived from the same timing signals used for loading the 1852, except that the "output device select" will be N = 5 for the lower 8 bits

(40193 A and B) and N = 4 for the upper 4 bits (40193 C).

In *normal* mode, the 12-bit latch is used as a byte counter with the built-in Direct Memory Access (DMA) feature of the 1802 microprocessor. This feature allows input or output from/to some external device directly into or out of memory. The microprocessor can preset the counter (up to 12 bits) to the desired DMA input/output byte count before initiating the transfer and be interrupted when that number of transfers is complete. Meanwhile, the processor can continue with other tasks while the transfers are taking place.

The "countdown" input to the 12-bit counter is a decoded state (S2—not to be confused with switch S2) signal from the

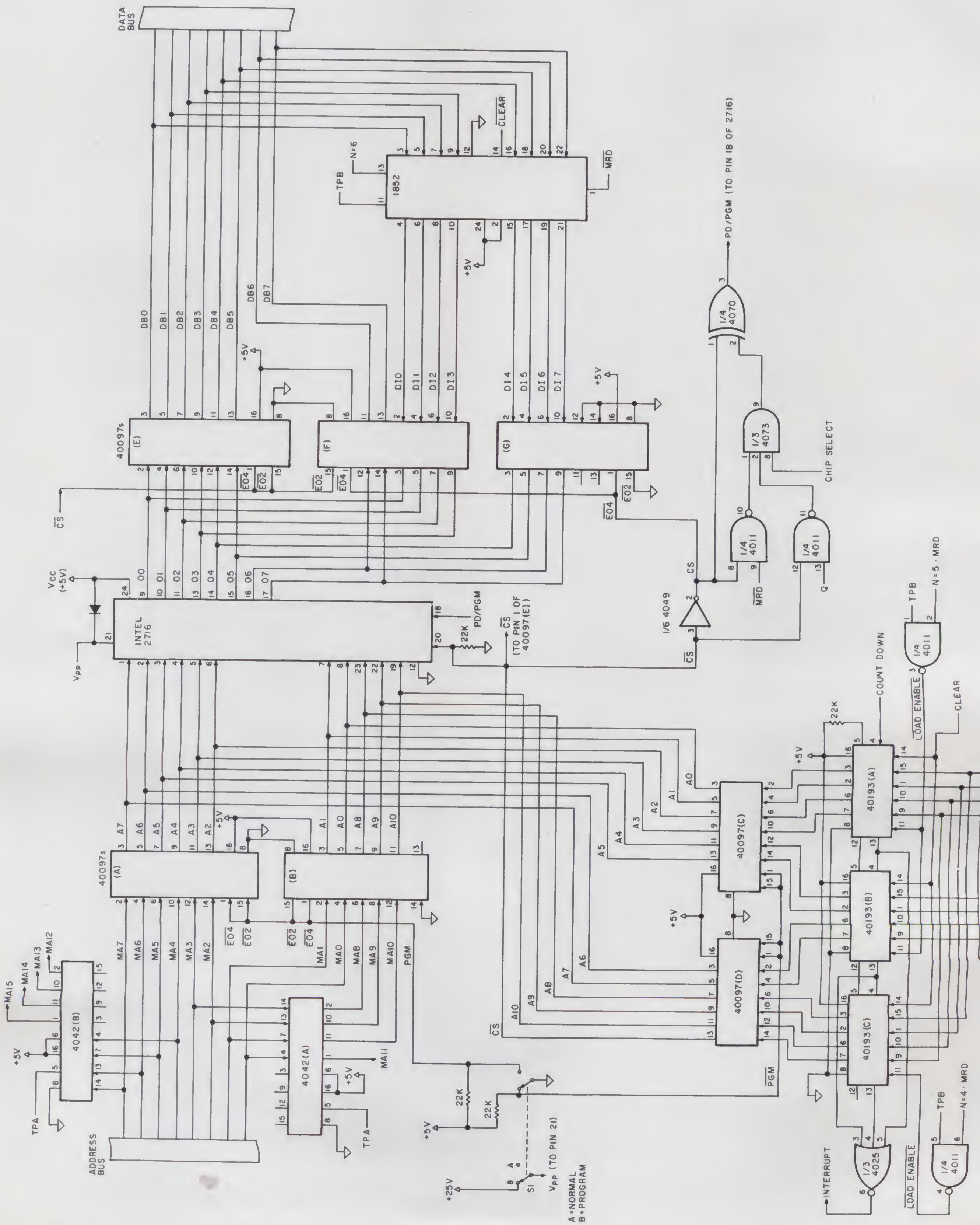

Fig. 4. Implementation of wiring diagram.

1802 which indicates when a DMA (input or output) memory reference takes place. The 22k resistor tied to pin 5 of 40193 A configures the counter to count *down* rather than count *up*. When "countdown" results in all 12 bits being zeros, an interrupt is generated, provided interrupts are enabled.

Again, for another type of microprocessor system, any simple equivalent 12-bit output latch implementation will work, and the timing of this latch's outputs are not critical. I included the above explanation of my multipurpose latch design as an aside for the benefit of any 1802 owners who may have an interest in this approach to DMA implementation.

The last unexplained item in Fig. 4 concerns the implementation of the $\overline{\text{Read}}$ and $\overline{\text{Program Pulse}}$ inputs (shown in Fig. 2) for the control signal, PD/PGM. The $\overline{\text{MRD}}$ input to the NAND gate (1/4 of 4011) is the same signal used for a timing input to the 1852.

During a normal read (and verify) sequence, this signal goes low for the memory read cycle. During a program sequence, this gate is disabled.

The "Q" input to the other NAND gate is a discrete signal directly from the 1802, whose state is controlled by executing 1802 instructions (SEQ sets Q high, REQ sets Q low). This NAND gate is disabled during a normal read (and verify) sequence and enabled during a program sequence.

During start-up initialization and prior to switching to *program* mode, this signal is set high. Subsequently, in the program sequence this signal is set low for a nominal 50 millisecond interval (2716 specs, say, 45 to 55 milliseconds).

The Program Controls the Time Interval

The interval for which this signal is set low is controlled by the number of times a software program count loop is entered and the time required for each loop. Both of these factors will vary with the microprocessor system used. In my 1802 system, a machine cycle requires three microseconds.

Fig. 5 shows a flow diagram for controlling the programming pulse, the machine and assembly code for the 1802 and the times associated with the program instructions. Note that there are two loops to check for COUNT = 0, just as there are two steps in loading the count. The loop count is held in the 16-bit general-purpose register number 9.

To check the contents of the 16-bit register for zero, the lower eight bits and upper eight bits must be loaded separately into the 1802's D register and checked. Thus, for every 256 times the lower eight bits are checked for zero, the upper eight bits will be checked once.

In calculating the times contributed by the REQ and SEQ instructions, only one machine cycle (three microseconds) for each instruction was used, since the state-change of Q occurs at the same point in the second machine cycle of each instruction. The program given in Fig. 5 provides a time interval of 50,004 microseconds for the programming pulse, or four microseconds more than the nominal 50 milliseconds specified.

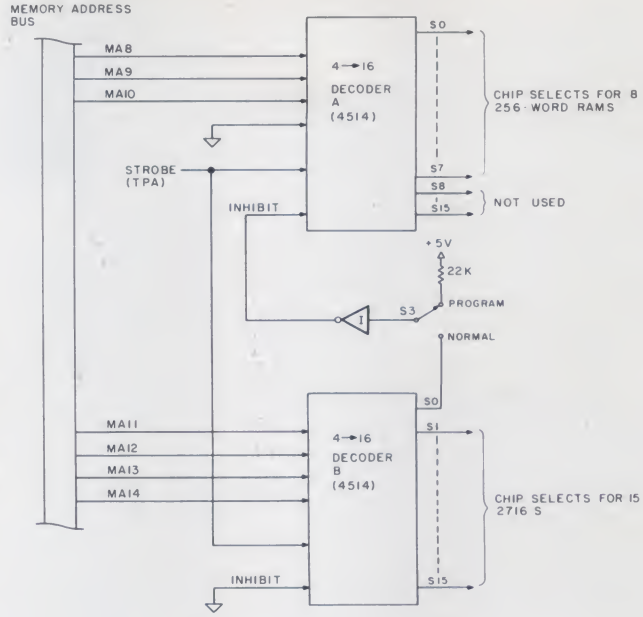

Fig. 6. Modified memory select circuit.

Time Out!

At this point I must take time to explain something I have done in implementing the "chip select" signal for the 2716 in order to "trick" the system and avoid having separate chip select circuits while programming.

In my system I use the lower 2048 memory addresses for addressing RAM memory. It is in the lower 256 words of this RAM memory that I load the software routines that program the 2716s. The chip select circuit for this RAM is shown in Fig. 6 (decoder A), along with the chip selects for the 2716s (decoder B).

Memory address bits 8, 9 and 10 select one of eight 256-word "chips" of RAM, provided memory address bits 11 through 14 are zero. Memory address bits 11 through 14 select one of fifteen 2716s, provided they are not all zero.

ABSOLUTE HEX ADDRESS	HEX CODE	ASSEMBLY CODE	COMMENTS	MACHINE CYCLES	MICROSECONDS
0080	7A	REQ	RESET Q	2	6
0081	F8	LDI D1	LOAD D WITH	2	6
0082	D1		LOWER COUNT BYTE	-	-
0083	A9	PLO 9	(D)→R(9).0	2	6
0084	F8	LDI 0A	LOAD D WITH	2	6
0085	0A		UPPER COUNT BYTE	-	-
0086	B9	PHI 9	(D)→R(9).1	2	6
0087	29 LOOP	DEC 9	DECREMENT R9	2	6
0088	89	GLO 9	[R(9).0]→D	2	6
0089	3A	BNZ LOOP	BRANCH IF NONZERO	2	6
008A	87		LOOP ADDRESS	-	-
0088	99	GHI 9	[R(9).1]→D	2	6
008C	3A	BNZ LOOP	BRANCH IF NONZERO	2	6
008D	87		LOOP ADDRESS	-	-
008E	7B	SEQ	SET Q	2	6

*ONLY 1 MACHINE CYCLE FOR EACH OF THE REQ AND SEQ INSTRUCTIONS IS INCLUDED

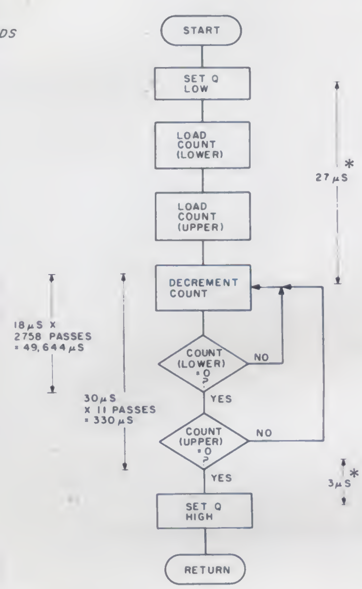

Fig. 5. Flow and timing for the program pulse.

When memory address bits 11 through 14 are all zero, the S0 output of their decoder is normally inverted and used to enable (INHIBIT is low) the selection of RAM. However, in *program* mode, the selection of RAM is always enabled through switch S3, regardless of the state of memory address bits 11 through 14.

During that part of my program when I want chip select (for the 2716 being programmed or verified) to be active, I ensure that the upper half of the P (program address) register has bits 11 through 14 configured to activate the chip select in the same manner as if I were executing a program from that (selected) 2716. In the meantime, my program will really be executing from the 256 lowest absolute RAM addresses.

When programming EPROM locations 2048 through 4095 (S1 of decoder B in Fig. 6 is active), for example, the P register, during execution of the routine shown in Fig. 5, will contain (hex) 08XX, where XX will be one of the 15 instruction addresses given. The upper eight bits of P (hex 08) will ensure that only the 2716 whose chip enable comes from the S1 output (of decoder B in Fig. 6) will be programmed. The specific address programmed in that 2716 will be determined by the contents of the 11-bit address latch shown in Fig. 4.

For those not familiar with the organization of, and the notation used for, the 1802 microprocessor, the 1802 has 16 addressable 16-bit registers, designated (in hex notation) by R(0) through R(F). Since the 1802 is an 8-bit device, manipulation of data in these registers, except for incrementing and decrementing, must be done in 8-bit bytes. (Incrementing and decrementing operations treat the contents of the registers as 16-bit quantities.)

To designate the lower half or upper half of a 16-bit register, the notation R(N).0 and R(N).1, respectively, is used (N = 0 to F). One of these 16 registers (R(P), where P = 0 to F) is used as a program address register.

Program branch or "JUMP" instructions in the 1802 are of two basic types: (1) short branch involves changing only the lower half of the instruction address register and therefore limits branching to a 256-word region in memory; (2) long branch involves changing both the upper and lower halves of the instruction address register and permits branching to anywhere in up to 64K of available memory. The long branch instruction could be used to set R(P).1 (upper) to select and deselect the 2716 being programmed.

Another way of accomplishing the same thing, and the way I use here, is to switch to another of the 16 registers (at the appropriate time in the instruction sequence) for the next instruction address. This is done with an SEP N (set P) instruction, where N (N = 0 to F) designates the register to be used for addressing the next instruction following SEP N.

Prior to executing SEP N, the upper half of R(N) must have been set to hex 08 to select, or hex 00 to deselect, the chip being programmed in my example. This approach is used in steps 20 and 28 of the sequence shown in Fig. 7, which is discussed next.

Putting It All Together

We've seen how the address and data lines of the 2716 have been set up for isolation from the respective buses of the microprocessor system and how the microprocessor software controls the programming and verifying sequence. Now let's summarize an entire sequence for initializing the system and then programming all locations of a 2716, starting at location 2048. (Table 2 gives other 2716 starting and ending addresses, corresponding to their respective chip select signals.)

This sequence assumes that the source of the initial address and, subsequently, each byte of data to be programmed comes from a hex keyboard with device address of N = 7. It also assumes that all data following the initial address is to be programmed into sequential addresses, starting with the initial address.

Fig. 7 gives a flow diagram of the sequence. Each step in the flow diagram is numbered to make it easier to proceed through the following discussion.

Steps 1 through 4 are preceded with a program load into RAM. When reset is performed, the interrupt is enabled, Q is reset to low and all 16-bit registers except R(0) are left in an indeterminate state. Thus the need for the initialization of registers, interrupt enable and Q.

The blinking display at step 5

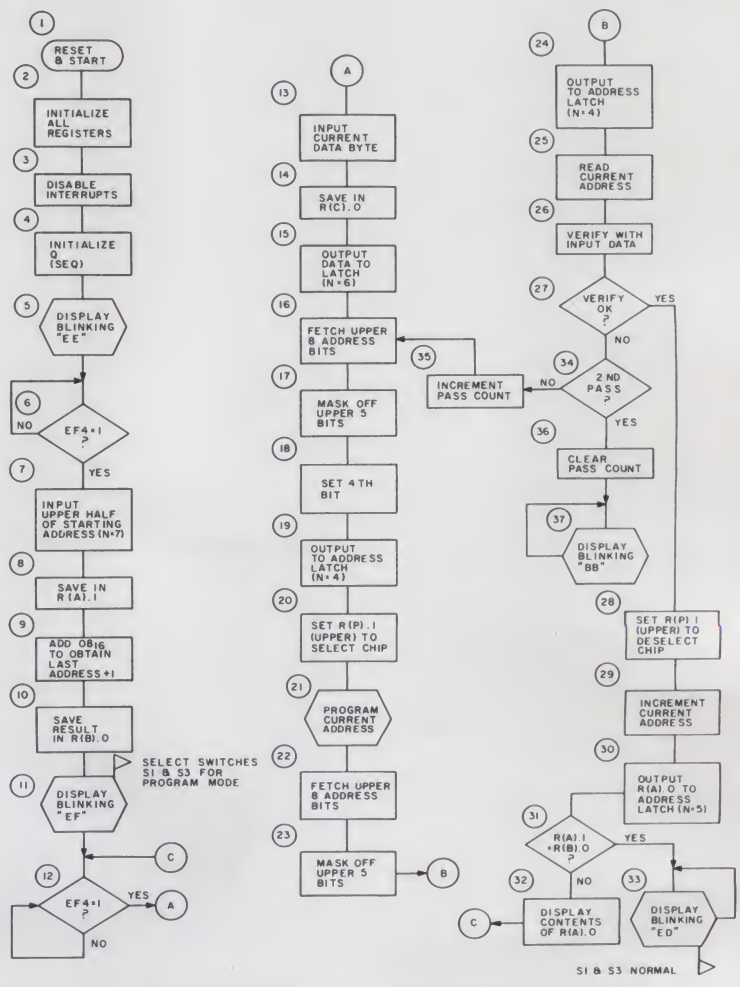

Fig. 7. Program sequence flow diagram.

2716 Chip Select	Starting Address		Ending Address	
	Hex	*Decimal*	*Hex*	*Decimal*
S1	0800	2048	0FFF	4095
S2	1000	4096	17FF	6143
S3	1800	6144	1FFF	8191
S4	2000	8192	27FF	10239
S5	2800	10240	2FFF	12287
S6	3000	12288	37FF	14335
S7	3800	14336	3FFF	16383
S8	4000	16384	47FF	18431
S9	4800	18432	4FFF	20479
S10	5000	20480	57FF	22527
S11	5800	22528	5FFF	24575
S12	6000	24576	67FF	26623
S13	6800	26624	6FFF	28671
S14	7000	28672	77FF	30719
S15	7800	30720	7FFF	32767

Table 2. Starting and ending addresses of 2716s.

lets the operator know that initialization is complete and the program is ready for input of the address. Step 6 senses an "input ready" signal. When input is ready, step 7 reads in the upper half of the starting address. (Since the lower half of the starting address is zero, there is no need to input a second address byte.) The upper address byte is saved (step 8) in the upper half of R(A), and R(A) is subsequently used in steps 29 and 30 to maintain the current address to be programmed.

Steps 9 and 10 establish a value to be used in step 31 to determine if the last address has been programmed. The blinking display at step 11 lets the operator know that the program is ready to proceed with data input and programming. At this step the operator selects the manual switches S1 and S3 for *program* mode.

Steps 12 and 13 input the current byte of data to be programmed from the keyboard. Steps 14 and 15 save the data byte in temporary storage for use in verifying at steps 26 and 27 and also load the 1852 latch shown in Fig. 4.

Steps 16 through 19 generate and output the upper 4 bits of the 12-bit address-latch contents. Setting (steps 18 and 19) and clearing (steps 23 and 24) the 12th bit controls $\overline{CS}$ and, therefore, conditions selection of the 2716 for programming and verifying, respectively.

Step 20 sets the instruction address register to select the 2716 to be programmed, as discussed previously. Step 21 includes all the steps illustrated in Fig. 5, which applies a timed programming pulse to the selected 2716. Step 22 fetches the same address byte (from R(A).1) as step 16.

Steps 25 through 27 read and verify that the contents of the 2716 address just programmed in step 21 are the same as the data byte previously input at step 13. If the verify checks OK, step 28 deselects the 2716. This step is not absolutely necessary for a debugged program but is included more as a factor to increase my confidence that a 2716 is selected *only* while absolutely necessary to program and verify. Another programmer may choose to delete this step and, in addition, shift step 20 to follow step 11, with little consequence.

Steps 29 and 30 increment the 2716 address in preparation for input and programming the next data byte. Remember: I previously stated that incrementing a 16-bit register in the 1802 treats the register as a 16-bit number. This permits step 31 to merely check the upper half of R(A) with the value previously stored in R(B).0 (at step 10) in order to determine if the last 2716 address has been programmed.

If it has, step 33 signals the operator that programming the 2716 is complete, and he can set switches S1 and S3 back to *normal*. If it has not, I display the lower eight address bits (step 32) as an operator aid and reminder of the progress in programming the 2716. The display represents the next address (in a 256-word region) to be programmed by repeating steps 12 and following.

At step 27, if the verifying does not check correctly, succeeding steps (34 through 37) may be rather arbitrary. I chose to set a flag and try one more attempt at programming the current address with the intended data. If the second attempt fails, the operator is notified by the blinking display and can take whatever subsequent action he feels necessary.

Conclusion

While the added cost of implementation of in-circuit programming of EPROMs may be a questionable trade-off, it is clear in my mind that this approach is far more economical than the purchase of a separate, off-line programmer. The payoff will come later when (and if) I arrive at an acceptable approach to *erasing* the individual 2716s under microprocessor-program control. ■

Use TI EPROMs with Your MP-A2 Board

This money-saving mod lets you plug those 3-voltage 2716s into your SWTP uP board.

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The SWTP MP-A2 microprocessor board has socket provisions for up to four 2K Intel 2716 EPROMs. The Intel 2716 requires only a single +5 V power supply, but is nearly twice as expensive as a functionally equal TI TMS 2716, which requires three different supply voltages. With about $100 savings in mind, I decided that it was worth considerable effort to see if the SWTP MP-A2 board could be adapted to enable use of the TMS 2716 EPROMs. My efforts were quite successful, with only a few minor revisions on the board being required.

Modifications

The Intel 2716 and TMS 2716 EPROMs are functionally equivalent and pin-for-pin compatible except for four pins (18, 19, 20 and 21). Table 1 shows the pin functions for both ICs. With reference to the SWTP MP-A2 board, pins 21 of ICs 23, 24, 25 and 26 are connected together as a group and connect to +5 V at only one point at pin 21 of IC24 on the bottom of the board. Carefully cut the +5 V supply bus loose at IC24, pin 21. Pin 21 will be connected to a −5 V source later. Pin 18s of ICs 23, 24, 25 and 26 are also connected together as a group and tie to ground at pin 18 of IC24 on the bottom of the board. Again, carefully cut the ground bus loose at IC24, pin 18. Pin 18 will be connected to a +12 V source later.

With reference to Fig. 1, the rewiring of pins 18, 19 and 20 can best be accomplished by using four piggyback adapters, each consisting of a 24-pin DIP plug and a 24-pin DIP socket. I found that the only jumper required was the connection from the TMS 2716 socket pin 18 to DIP socket pin 20 on each adapter (see Photo 1). Use of these socket adapters saves a lot of cutting and jumpering on the MP-A2 board.

The SWTP system already has +12 V and −12 V buses. My buses are regulated at the power supply; therefore, the +12 V supply was used without any further conditioning. IC24,

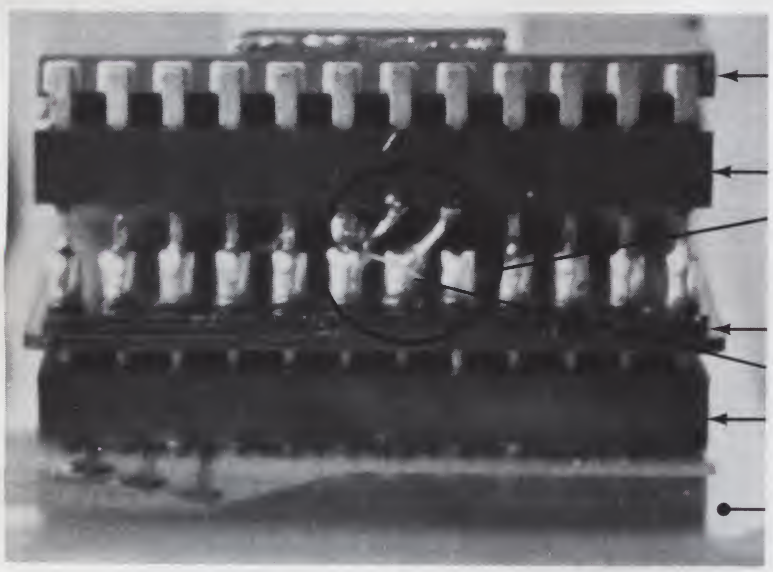

Photo 1. Piggyback adapter.

TMS	INTEL	PIN	PIN	INTEL	TMS
A7	A7	1	24	+5 V	+5 V
A6	A6	2	23	A8	A8
A5	A5	3	22	A9	A9
A4	A4	4	21	+5 V	−5V
A3	A3	5	20	$\overline{CS}$	A10
A2	A2	6	19	A10	+12 V
A1	A1	7	18	PROG	$\overline{CS}$
A0	A0	8	17	D7	D7
D0	D0	9	16	D6	D6
D1	D1	10	15	D5	D5
D2	D2	11	14	D4	D4
GND	GND	12	13	D3	D3

Table 1. Pin functions for intel and TMS 2716s.

pin 18, was jumpered directly to the +12 V pin. I added a 7905 −5 V regulator off the −12 V bus to supply −5 V to IC24, pin 21. There is a small open space between IC22 and IC17 on the bottom of the MP-A2 board in which I mounted the 7905 −5 V regulator (see Photo 2).

If you are fussy about drilling and cutting your board, then user-defined lines, UD1 and UD2, can be used for the extra +12 V and −5 V supply lines, with all voltage regulation done elsewhere off-board. Additionally, as shown in Fig. 2, the +12 V and −5 V connections on the piggyback adapters could be left open with power-supply jumpering being done on the TMS 2716 sockets only. This would avoid the necessity of making any revisions on the MP-A2 board (except soldering to the UD1 and UD2 lines). ■

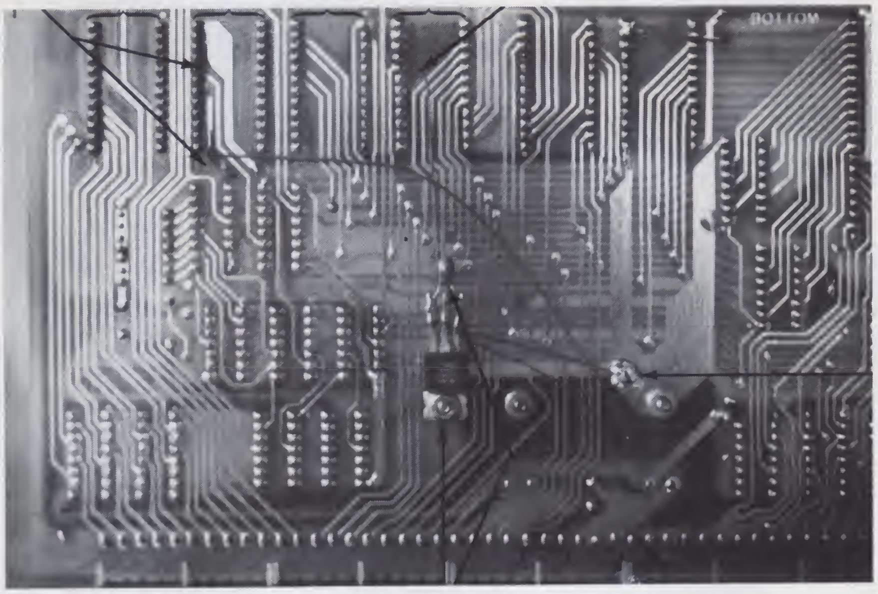

Photo 2. MP-A2 microprocessor board.

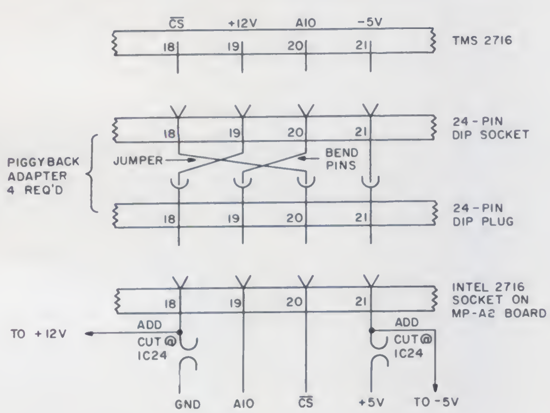

Fig. 1. Rewiring pins 18, 19 and 20.

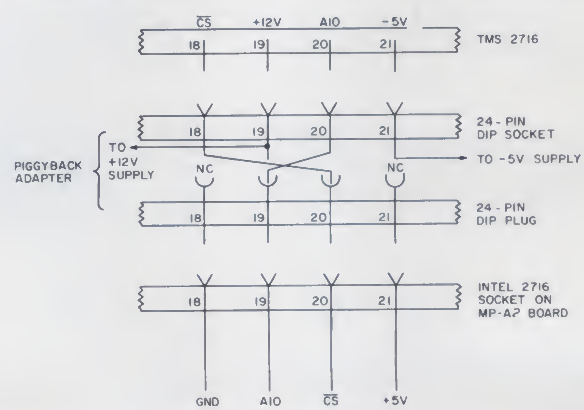

Fig. 2. Alternate method for +12 V and −5 V supplies to TMS 2716 EPROMs. This leaves the MP-A2 board intact.

✓ *Reader Service—see page 227*

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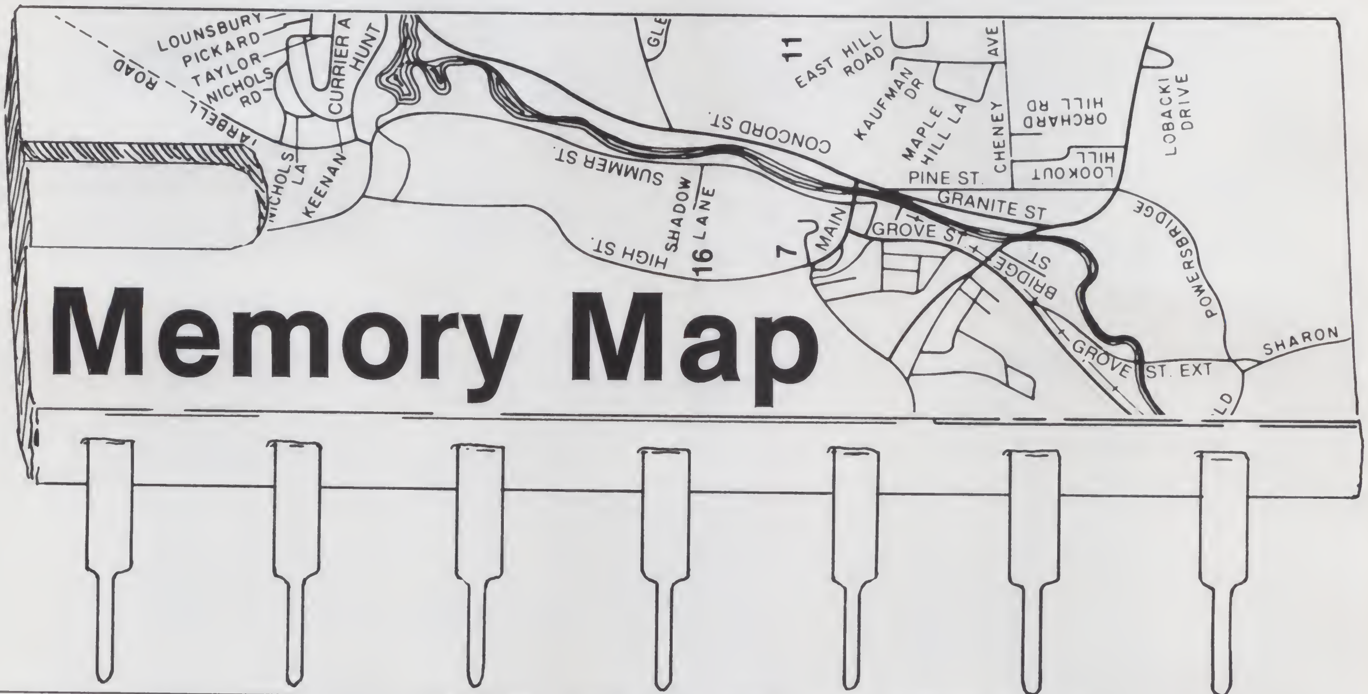


Memory Map

"Memory Map" is a useful diagnostic for any computer system. In this article a rather complicated system is explained and used for an example to illustrate how the program works.

A friend of mine, whose name and credentials are best not mentioned at this time, spent an embarrassing length of time one day futilely attempting to load BASIC into his Altair. After all, it had been running the day before, so there couldn't be anything wrong with the processor. Besides, the monitor program he had written and placed in EPROMs (erasable, programmable, read-only memory) was working fine. After altogether too many passes down the tape, he finally gave up and removed the Altair's cover.

One of his students had "borrowed" a 4K memory board, right out of the middle of the RAM (random access read-write memory) array! At the time this happened I thought it was rather funny.

Some time later, while bringing up my multiple-processor system (you can't do any serious computing with only one CPU and less than 64K of RAM, can you?), *I* spent an embarrassing length of time trying to print an assembly listing on my Teletype. After all, it had been running the day before. I wasted a lot of time debugging hardware that was in perfect shape.

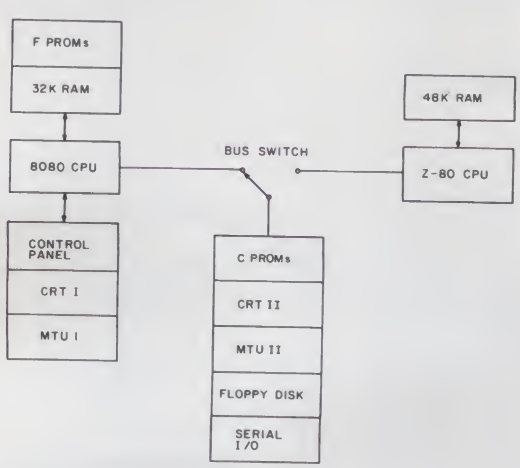


Fig. 1. A simplified block diagram of the computer system used to illustrate the functioning of the Memory Map program. Two processors share a block of memory and I/O resources.

Fig. 1 is a simplified block diagram of the multi-CPU system. The assembly-language software runs on the 8080 and uses the terminal labeled CRT I. But the printer is accessed through the shared resources. Some idiot had left the manual bus switch in the wrong position!

Of course, these are only a couple of the kinds of problems that can cause you to become prematurely gray. Either problem could have been caused by a real hardware failure, a dead bug or a dirty card-edge connector. When strange symptoms occur, what is needed is a quick check of your computer's resources to point out hardware failures, borrowers or operator idiocies.

Since my system was becoming so complicated that I couldn't even remember to set all the switches correctly, I developed the memory resource checking program described here. While not an exhaustive diagnostic program, it serves as a quick peek at a system's address space, and thus will enable you to quickly detect the absence or failure of any major component. Even if your system is not as complicated as mine, Memory Map can prove to be a valuable diagnostic aid.

In order to completely understand the program, we will have to digress a bit and take a quick look at how my development system is organized, since it is used in the map examples.

The Hardware

Fig. 1 shows the basic arrangement of the hardware components. The 8080 system has been in operation since 1975 and includes a "smart"

control panel, a 24 line by 64 character CRT display and an audio tape interface (MTU1). The 8080 bus connects a 32K byte RAM memory and eight 1702A EPROMs, which contain the control routines for MTU 1, CRT 1 and the control panel, as well as the usual utility routines.

As additions to this system were built, they were organized in a separate package connected to the 8080 bus by ribbon cable, in anticipation of future system reconfigurations. This group of resources includes a second CRT display (two pages of 32 lines by 64 characters and a 96 by 128 dot matrix graphic capability), a second mag-tape interface, a floppy-disk controller, a driver for my Teletype and a bank of 2708 EPROMs, beginning at address C000, that contains the driver routines for the devices in this group. An electronic bus switch enables these devices and their drivers in the C PROMs to be instantly switched between the old 8080 system bus and the CPU bus of a second processor, currently a Z-80.

The bus switch is shown schematically as a single-pole, double-throw, manual switch, and there is indeed a manual override switch to control the bus switch in case the two processors start fighting over who gets to use the shared resources. It was this manual switch that was left in the wrong position (could I have done such a thing?), leaving the 8080 with no access to the Teletype interface.

The Memory Address Space

Looking now at Fig. 2, we can see how the address spaces of both CPUs are organized. Both CRT display memories are part of the CPU address space, permitting the displays to be updated much more rapidly than they could be if connected through serial access ports. A 4K byte CMOS RAM board with battery backup and a write protect switch is used as a "temporary ROM" for program development, and so "floats" around in the memory address space, being used wherever it is needed

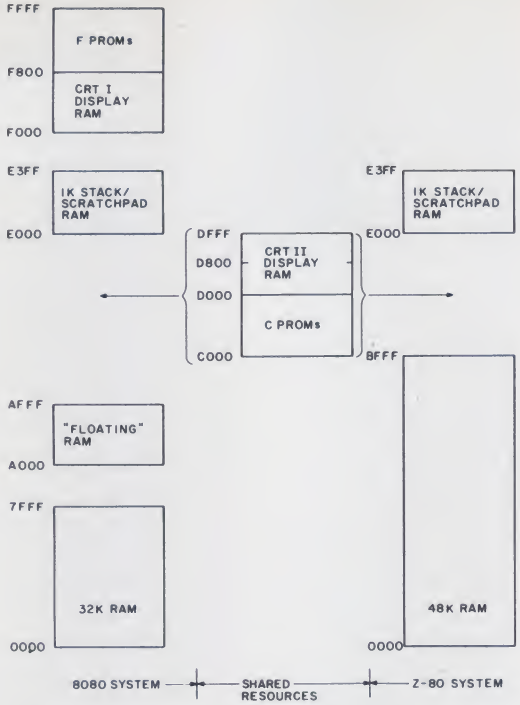


Fig. 2. The memory maps of the two processors. The RAM and ROM memory segments of the shared resources can appear in the address space of either processor, depending on the position of the bus switch.

at the moment. It is hard to believe, but when this project started I thought that this 4K board would be all the memory I'd ever need! Oh, my innocence in the year 1975!

Both CPUs have their own little 1K byte RAM dedicated for the stack and miscellaneous use. These little blocks of memory reside at the same address on both CPU boards, so the programs in the C PROMs can always find them. And being isolated from the main RAM, they are protected from programs such as BASIC that start off by searching for the top of contiguous main memory. All CPU boards should have this feature.

But putting these asides aside, the reason for this discussion is so you will understand the examples of memory maps our program will be generating. Your system does not have to be all this complicated for Memory Map to be a useful part of your system diagnostics.

Using Memory Map

Keeping in mind the complexities of Fig. 2, refer to the maps generated by this program and shown in Fig. 3, which shows the memory space of the 8080 processor when it has control of the shared resources. Reading down from the top of Fig. 3a (from the bottom of memory up), we see the 32K RAM properly identified, followed by empty space (MT) between addresses 8000 and 9FFF in hexadecimal. The floating RAM board is identified as ROM, because we have left its write protect switch in the PROTECT position, in order to emulate read-only memory.

There follows more empty space, and since the CPU that called Memory Map has the shared resources, the next item we see are the C PROMs. In this case, three 2708 EPROMs are in their sockets, occupying addresses C000 through CBFF. An empty socket at CC00 is properly identified.

The display RAM for CRT II fills the space from D000 through DFFF, but immediately following this is our 1K scratchpad RAM, so to the map program this all appears (as it should) as a contiguous block of RAM starting at D000 and extending up through address E3FF. There follows more empty space, then CRT I's display RAM and the F PROMs.

Comparing Fig. 3b with 3a, the only difference between the two maps is that the floating RAM is now identified as accessible for writing because we have changed the setting of the write protect switch. See what a convenient program Memory Map is? If my friend had had it in his Altair, he could have found out in seconds that he had an MT spot in the middle of his memory. Then maybe his student would have gotten off with a verbal reproof instead of an F.

How the Program Works

Memory Map tests the address space in 1K byte increments from address 0000 through FFFF (if your system needs to be tested with more resolution, it is only necessary to change the number of increments loaded into register C and the increment size loaded into the D, E register pair in the first lines of the program). The flowchart in Fig. 4 is a lot easier to follow than the program listing.

```
0000 7FFF  =RAM
8000 9FFF  =MT
A000 AFFF  =ROM
B000 BFFF  =MT
C000 CBFF  =ROM
CC00 CFFF  =MT
D000 E3FF  =RAM
E400 EFFF  =MT
F000 F7FF  =RAM
F800 FFFF  =ROM

0000 7FFF  =RAM
8000 9FFF  =MT
A000 AFFF  =RAM
B000 BFFF  =MT
C000 CBFF  =ROM
CC00 CFFF  =MT
D000 E3FF  =RAM
E400 EFFF  =MT
F000 F7FF  =RAM
F800 FFFF  =ROM
```

Fig. 3. Maps produced by the program, showing the address space of the 8080 CPU when it has control of the shared resources.

After printing the initial address, the program calls the subroutine TSTLC (TeST LoCation) to determine if the currently addressed location is read-write memory (RAM). It does this without destroying the memory contents. The contents are first saved, then TSTLC sees if it can

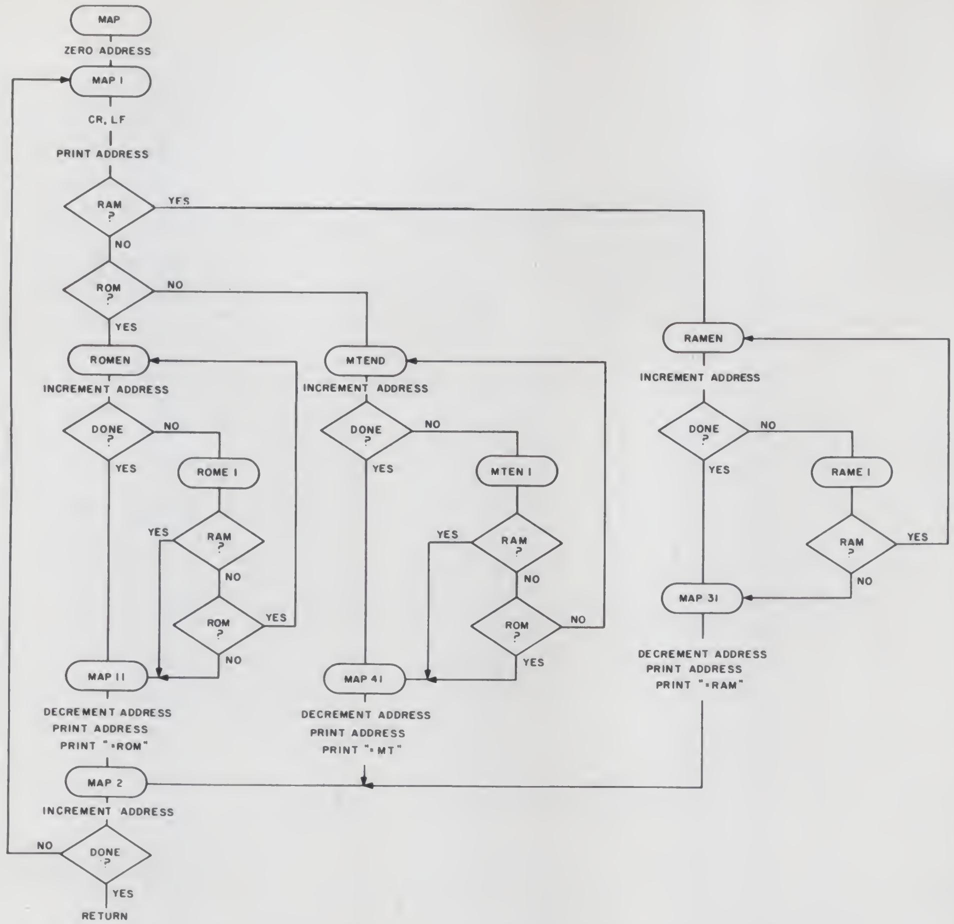


Fig. 4. The flowchart of the Memory Map subroutine, which decides whether a particular memory location contains RAM, ROM or is empty.

write all zeros and then all ones into the memory. Then the original contents are returned to memory.

It should be noted here that if any one bit of the memory word tested is not working, it will not be identified as RAM. Even though this program is not a complete memory diagnostic, it will detect the presence of any single dead RAM chip in the system by deciding that it is not RAM when we know it should be.

If the memory location accepts all zeros and then all ones, the program will jump to RAMEN (find RAM ENd) and continue testing until it finds the first address that will not accept the write-read operations. Since this address is the first non-RAM location, a decrement of one is made to the address (back to RAM), and this address is displayed, followed by the message "=RAM." Then at MAP2 we re-increment the address and test to see if we have checked all the memory. If not, we jump back to MAP1 and start another line.

If no RAM is found at an address, the program calls TSTRO (TeST ROm). Here the program assumes that the first three locations of a read-only memory will not contain all ones (FF, FF, FF in hex), since this is not a meaningful code sequence. If any other pattern is found, we will jump to ROMEN and search for the end of ROM.

A properly terminated data bus will return all ones (FF) when a read-memory instruction is executed at an address that has no RAM or ROM in it. Our program relies on this fact to decide that such a memory address is empty. When this decision is reached, the program jumps to MTEND to find the end of the empty space.

ADRS	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	ADRS
0000	0E	40	21	00	00	11	00	04	CD	39	03	CD	E3	00	CD	74	000F
0010	00	CA	40	00	E5	CD	80	00	E1	CA	55	00	19	0D	CA	2F	001F
0020	00	CD	74	00	CA	2F	00	E5	CD	80	00	E1	C2	1C	00	2B	002F
0030	0C	CD	E8	00	CD	8A	00	23	0D	C2	08	00	CD	39	00	C9	003F
0040	19	0D	CA	4B	00	CD	74	00	CA	40	00	2B	0C	CD	E8	00	004F
0050	CD	91	00	C3	37	00	19	0D	CA	69	00	CD	74	00	CA	69	005F
0060	00	E5	CD	80	00	E1	CA	56	00	2B	0C	CD	E8	00	CD	98	006F
0070	00	C3	37	00	46	AF	77	BE	C2	7E	00	3D	77	BE	70	C9	007F
0080	3E	FF	BE	C0	23	BE	C0	23	BE	C9	E5	21	A5	00	C3	9C	008F
0090	00	E5	21	B0	00	C3	9C	00	E5	21	B5	00	7E	FE	00	CA	009F
00A0	A9	00	CD	33	C4	23	C3	9C	00	E1	C9	3D	52	4F	4D	00	00AF
00B0	3D	52	41	4D	00	3D	4D	54	00	3E	0D	CD	33	C4	3E	0A	00BF
00C0	C3	33	C4	3E	20	C3	33	C4	7C	CD	CD	00	7D	F5	E6	F0	00CF
00D0	0F	0F	0F	0F	CD	DA	00	F1	E6	0F	FE	0A	FA	E1	00	C6	00DF
00E0	07	C6	30	E6	7F	C3	33	C4	CD	C8	00	C3	C3	00	CD	CD	00EF
00F0	00	C3	C3	00													
ADRS	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	ADRS

Fig. 5. A hexadecimal dump of the 8080 code of Memory Map. It is assembled at location 0000 to make it easier to relocate the code, working from this dump if necessary.

If your system includes a read-only memory that begins with the code sequence FF, FF, FF, you might fool this program, and you'll make me wonder what in the world that ROM is doing!

Putting Memory Map into Your System

The program as assembled for the listing and for the object code dump in Fig. 5 begins at location 0000 in order to make it easier for you to relocate it in your system. You could key it into RAM at location 0000 and use it as an initial test before loading your application program, but you really should burn it into a PROM so it will be ready for those terrible days when everything seems to check, but nothing works.

The only external reference in the program is to the console output routine (CO), which you must supply. Memory Map calls CO with a 7-bit ASCII character in the A register, and expects the contents of all other registers to remain unchanged. If your console output routine changes any of the other registers, you will have to save and restore them at the entry point and exit from your console output subroutine.

Included at No Extra Cost

Some of the utility routines beginning at location 00B9 in the listing may already exist in your computer's monitor. If not, they should, if you do much machine-language or assembly-language work. For example, a single CALL ADRSP instruction will cause the contents of the H,L register pair to be output to the console as four hexadecimal characters followed by a space. This is used, for example to print the first five positions on each line of an assembly listing, as in our example. BYTSP can be called to print the contents of the accumulator as two hex characters followed by a space. Calls to

ADRCO or BYTCO will cause the contents of H,L or A to print without the space.

If you want to borrow these subroutines for use in your system, note that ADRCO "falls through" into the beginning of BYTCO, which, in turn, falls through into NYBCO. This is done to save memory space and requires that the three subroutines immediately follow each other in the order shown. Otherwise, more CALLs and RETs will have to be added to the code.

Notes on the Assembly Listing

The listing was produced by SCORE, my SCreen-ORiented Editor, assembler and utility system. SCORE was optimized for use on a system intended for the development of programs for control systems, rather than for computational use. For this reason, all numeric values entered default to hexadecimal, rather than the usual decimal, so you don't have to append a code character to tell the system that it is a hex value. Working at this level, you will seldom be using decimal numbers anyway.

SCORE is also smart enough to know that if the first character on a line is not a space, then it is the first character of a label. No extra characters need be appended to labels. As text is input to SCORE, a single space, rather than a tab character, will advance you from the label field to the operation field, and from the operation field to the operand field, and then onto the comment field. This follows SCORE's basic philosophy—that no unnecessary keystroke will ever be required of the operator.

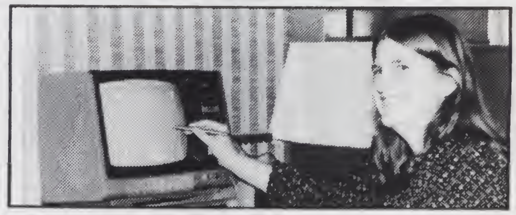
Why the "$" to designate a comment line? Well, it had to be some character that would not be the first character of a label, and the "$" on my surplus keyboard is a lowercase character, saving another keystroke. Besides, it's nice to have some $$$ around. ■

Memory Map program.

```
$ MEMORY MAP SUBROUTINE    25 FEB 79

                CO      EQU  C433          CONSOLE OUTPUT

                        ORG  0000

0000 0E40       MAP     MVI  C,40          64 INCREMENTS
0002 210000             LXI  H,0000        STARTING HERE
0005 110004             LXI  D,0400        1 K INCREMENT
0008 CDB900     MAP1    CALL CCRLF
000B CDE800             CALL ADRSP         SHOW START ADDRESS
000E CD7400             CALL TSTLC         ANY RAM?
0011 CA4000             JZ   RAMEN         YES, FIND END
0014 E5                 PUSH H             NO, LOOK FOR
0015 CD8000             CALL TSTRO         ROM
0018 E1                 POP  H
0019 CA5600             JZ   MTEND         NONE, FIND SOME
001C 19         ROMEN   DAD  D             FIND END OF ROM
001D 0D                 DCR  C
001E CA2F00             JZ   MAP11         OR END OF MEMORY
0021 CD7400     ROME1   CALL TSTLC         ANY RAM?
0024 CA2F00             JZ   MAP11         YES, END OF ROM
0027 E5                 PUSH H
0028 CD8000             CALL TSTRO
002B E1                 POP  H             ANY EMPTY?
002C C21C00             JNZ  ROMEN         NO, STILL ROM
002F 2B         MAP11   DCX  H             SHOW END OF ROM
0030 0C                 INR  C             CORRECT COUNTER
0031 CDE800             CALL ADRSP         SHOW END ADDRESS
0034 CD8A00             CALL ROMMS         LABLE IT
0037 23         MAP2    INX  H             RESTORE H
0038 0D                 DCR  C             TIL DONE
0039 C20800             JNZ  MAP1
003C CDB900             CALL CCRLF
003F C9                 RET
0040 19         RAMEN   DAD  D             FIND END OF RAM
0041 0D                 DCR  C
0042 CA4B00             JZ   MAP31         OR MEMORY
0045 CD7400     RAME1   CALL TSTLC         STILL RAM?
0048 CA4000             JZ   RAMEN         YES
004B 2B         MAP31   DCX  H             NO, SHOW END
004C 0C                 INR  C             CORRECT COUNTER
004D CDE800             CALL ADRSP         SHOW ADDRESS
0050 CD9100             CALL RAMMS         AND LABLE
0053 C33700             JMP  MAP2
0056 19         MTEND   DAD  D             LOOK FOR SOMETHING
0057 0D                 DCR  C
0058 CA6900             JZ   MAP41         OR END OF MEMORY
005B CD7400     MTEN1   CALL TSTLC         ANY RAM?
005E CA6900             JZ   MAP41
0061 E5                 PUSH H
0062 CD8000             CALL TSTRO         OR ROM?
0065 E1                 POP  H
0066 CA5600             JZ   MTEND
0069 2B         MAP41   DCX  H
006A 0C                 INR  C
006B CDE800             CALL ADRSP
006E CD9800             CALL MTMSG
0071 C33700             JMP  MAP2

0074 46         TSTLC   MOV  B,M           TEST LOC (H,L)
0075 AF                 XRA  A             TEST 0'S
0076 77                 MOV  M,A
0077 BE                 CMP  M
0078 C27E00             JNZ  TSTL1         NOT HERE
007B 3D                 DCR  A             TEST 1'S
007C 77                 MOV  M,A
007D BE                 CMP  M
007E 70         TSTL1   MOV  M,B           RESTORE RAM
007F C9                 RET
0080 3EFF       TSTRO   MVI  A,0FF         MT = FF
0082 BE                 CMP  M
0083 C0                 RNZ
0084 23                 INX  H
0085 BE                 CMP  M
0086 C0                 RNZ
0087 23                 INX  H
0088 BE                 CMP  M
0089 C9                 RET

008A E5         ROMMS   PUSH H             MESSAGES
008B 21AB00             LXI  H,ROM
008E C39C00             JMP  MSG
0091 E5         RAMMS   PUSH H
0092 21B000             LXI  H,RAM
0095 C39C00             JMP  MSG
0098 E5         MTMSG   PUSH H
0099 21B500             LXI  H,MT
009C 7E         MSG     MOV  A,M
009D FE00               CPI  00
009F CAA900             JZ   MSGEN
00A2 CD33C4             CALL CO
00A5 23                 INX  H
00A6 C39C00             JMP  MSG
00A9 E1         MSGEN   POP  H
00AA C9                 RET

00AB 3D524F4D   ROM     DB   '=ROM'
00AF 00                 DB   00
00B0 3D52414D   RAM     DB   '=RAM'
00B4 00                 DB   00
00B5 3D4D54     MT      DB   '=MT'
00B8 00                 DB   00
```

```
$ CONSOLE OUTPUT UTILITY ROUTINES

$ CARRIAGE RETURN, LINE FEED TO CONSOLE

00B9 3E0D       CCRLF   MVI  A,0D          CR
00BB CD33C4             CALL CO
00BE 3E0A               MVI  A,0A          LF
00C0 C333C4             JMP  CO

$ SPACE TO CONSOLE

00C3 3E20       SPCCO   MVI  A,20
00C5 C333C4             JMP  CO

$ (H,L) AS "ADDRESS" FIELD TO CONSOLE

00C6 7C         ADRCO   MOV  A,H           HIGH ORDER BYTE
00C9 CDCD00             CALL BYTCO         CONVERT TO HEX
00CC 7D                 MOV  A,L           LOW ORDER BYTE

$ (A) AS "BYTE" FIELD TO CONSOLE

00CD F5         BYTCO   PUSH PSW           SAVE (A)
00CE E6F0               ANI  F0            MASK HIGH ORDER NIBBLE
00D0 0F                 RRC                AND SHIFT IT TO
00D1 0F                 RRC                LOW ORDER 4 BITS
00D2 0F                 RRC
00D3 0F                 RRC
00D4 CDDA00             CALL NYBCO         WRITE IT TO CONSOLE
00D7 F1                 POP  PSW           GET LOW ORDER NIBBLE
00D8 E60F               ANI  0F

$ (A) AS 4 BIT "NIBBLE" TO CONSOLE

00DA FE0A       NYBCO   CPI  0A            GREATER THAN 10?
00DC FAE100             JM   NYBC1         NO, ADD 30 HEX
00DF C607               ADI  07            YES, ADD 7 EXTRA
00E1 C630       NYBC1   ADI  30            CONVERT TO ASCII
00E3 E67F               ANI  7F            MASK PARITY BIT
00E5 C333C4             JMP  CO            AND WRITE IT TO CONSOL

$ ADDRESS FIELD AND A SPACE TO CONSOLE

00E8 CDC600     ADRSP   CALL ADRCO
00EB C3C300             JMP  SPCCO

$ BYTE AND A SPACE TO CONSOLE

00EE CDCD00     BYTSP   CALL BYTCO
00F1 C3C300             JMP  SPCCO
```

Reader Service—see page 227



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Plotting Data or Functions

Make use of this program to do it the easy way.

The microcomputer has opened up new opportunities in information processing. Those of us who work in the physical sciences find it without equal for the inexpensive acquisition of experimental data or the analysis of experimental results.

But computers can be limiting, too. Altogether too often, the machine is used simply as a number cruncher, with numbers going in and numbers coming out. A table of analysis results that consists simply of two columns of numbers is not always meaningful. This is like handing a student a copy of the *Chemical Rubber Handbook*, having him open to the page that gives a table of four-place logarithms and saying, "See, this is how the log function behaves." If, on the other hand, you showed the same student a graph of log(x) vs x, the student could *see* the behavior of the function.

Seeing Is Believing

The same is true with experimental data. A table of data isn't always meaningful; experimenters tend to make plots of their results, plotting the dependent variable against the independent variable (results against the experimental parameter you varied). In this way you can see the behavior of your data and can easily compare it qualitatively to the behavior predicted by your pet theory.

When computers generate data or results and we then take pencil to graph paper, we are doing work the computer should be doing; the computer is making us do *its* work.

All this talk of plotting data and curves is very well, you might say, but who can afford $800 for an x-y plotter? Many people don't even have graphics on their CRT. It's nice to have hard copy, too, so you can take it to the boss and show him you were right in predicting the trends.

Most all microcomputer owners and users have some method of producing hard copy. Usually it is a printer or Teletype. The subroutine discussed here is a means of using your printing mechanism as a very coarse graphics unit to plot curves or data.

The Program

Listing 1 is a subroutine written in SWTP 8K BASIC version 2.2. It will print the x and y axes, with titles, and plot a table of values. As written, it requires approximately 2K of memory above BASIC and a calling routine, and will plot a 30 × 60

```
9500 REM PRPLOT
9501 REM PLOTS TABLE T1 ON PR40
9502 REM X$=X AXIS TITLE (INPUT)
9503 REM Y$=Y AXIS TITLE (INPUT)
9504 REM T2= NO OF POINTS(INPUT)
9505 REM T3= Y MAX
9506 REM T4= Y MIN
9507 REM T5= X MAX
9508 REM T6= X MIN
9509 REM T7= LENGTH OF X$
9510 REM T8= X STEPSIZE
9511 REM T9= Y STEPSIZE
9512 REM U6= Y PRINT POSITIONS
9513 REM U7= CURRENT X
9514 REM U8= NEXT DATA POINT
9515 REM U9= LETTER OF X$ TO PRINT
9516 REM TABLE T1 MUST BE SORTED SO
9517 REM THAT T1(I,1) IS IN INCREASING
9518 REM OR DECREASING ORDER
9520 PRINT #7,TAB(10);Y$
9525 REM FIND MAX AND MIN
9530  T3=-9.E99:T5=T3
9540  T4=9.E99:T6=T4
9550 FOR I1=1 TO T2
9560 IF T1(I1,2)>T3 THEN T3=T1(I1,2)
9570 IF T1(I1,1)>T5 THEN T5=T1(I1,1)
9580 IF T1(I1,2)<T4 THEN T4=T1(I1,2)
9590 IF T1(I1,1)<T6 THEN T6=T1(I1,1)
9600 NEXT I1
9605 REM PRINT Y AXIS HEADER
9610 PRINT #7
9614 DIGITS= 3
9615  U5=INT(2.3*LOG(ABS(T3)))
9616 IF U5<0 THEN DIGITS=ABS(U5)+1
9620 PRINT #7,TAB(6);T4;TAB(31);T3
9630 PRINT #7;TAB(10);
9640 FOR I1=1 TO 30
9650 PRINT #7,"-";
9660 NEXT I1
9665 PRINT #7
9670 DIGITS= 3
9680 REM COMPUTE STEPSIZE
9685  U8=1
9690  T8=(T5-T6)/60
9700  T9=(T3-T4)/30
9710 FOR I1=1 TO 60
9720  U9=ASC(X$)
9730 IF U9=0 THEN U9=32
9740  X$=MID$(X$,2)
9750  U7=T6+(I1-1)*T8
9755 REM PRINT X AXIS HEADER
9760 PRINT #7,CHR$(U9);CHR$(32);U7;CHR$(33);
9763 REM PRINT DATA POINT
9764 IF U8+1>=T2 THEN 9766
9765 IF U7>T1(U8+1,1)THEN U8=U8+1
9766 IF I1=60 THEN 9780
9770 IF U7<T1(U8,1)THEN 9840
9780  U6=INT((T1(U8,2)-T4)/T9-.01)
9785 IF U6<=0 THEN 9820
9790 FOR I2=1 TO U6
9800 PRINT #7,CHR$(32);
9810 NEXT I2
9820 PRINT #7,CHR$(42)
9825  U8=U8+1
9830 GOTO 9860
9840 PRINT #7,CHR$(32)
9860 NEXT I1
9870 PRINT #7,TAB(3);T5
9875 DIGITS= 0
9880 RETURN
```

Listing 1.

grid. The subroutine begins at line 9500 (line 9520, if you don't use the REMARK statements), so as not to interfere with any other program you may have. Most other programs begin at line 10.

To use the subroutine, Table T1 must be DIMENSIONed to (60,2) in the calling routine, and the x-values to be plotted are placed in T1 (I,1), while the y-values are placed in T1 (I,2), and I is the subscript denoting the x-y data pair. The data pairs *must* be placed into the table in either increasing or decreasing values of x. T2, the number of data points to be plotted, must also be computed in the calling program. Then all that is required is a GOSUB 9500, and the printer begins spewing out a plot.

Two examples of the use of the program are presented here. First, an example of the plotting of a function is shown. The particular function is $y = 3 \exp(-z/3) \cos(4z) + 10$. This is the equation for a sine wave that decays exponentially. We will plot it for $z = 0$ to $z = 6$.

Listing 2 shows a calling routine that creates 60 x-y pairs for $x = 0$ to $x = 6$ and places them in T1. The subroutine is called, and Fig. 1 is the result. Notice that the routine automatically sets the y-axis range

```
              Y=3 EXP(-Z/3)COS(4Z)+10

         7.706                    12.672
          ------------------------------
T 0.100 !                             *
H 0.198 !
I 0.296 !                         *
S 0.394 !                   *
  0.493 !             *
I 0.591 !       *
S 0.689 !  *
  0.788 !*
T 0.886 !*
H 0.984 ! *
E 1.083 !     *
  1.181 !         *
Z 1.279 !              *
  1.378 !                   *
A 1.476 !                      *
X 1.574 !                        *
I 1.673 !                        *
S 1.771 !                      *
  1.869 !                   *
  1.968 !                *
  2.066 !            *
  2.164 !         *
  2.263 !      *
  2.361 !     *
  2.459 !     *
  2.558 !       *
  2.656 !         *
  2.754 !            *
  2.853 !               *
  2.951 !                 *
  3.049 !                   *
  3.148 !                    *
  3.246 !                   *
  3.344 !                  *
  3.443 !                *
  3.541 !              *
  3.639 !           *
  3.738 !         *
  3.836 !        *
  3.934 !       *
  4.033 !        *
  4.131 !         *
  4.229 !          *
  4.328 !            *
  4.426 !              *
  4.524 !               *
  4.623 !                *
  4.721 !                *
  4.819 !                *
  4.918 !               *
  5.016 !              *
  5.114 !            *
  5.213 !           *
  5.311 !          *
  5.409 !          *
  5.508 !         *
  5.606 !          *
  5.704 !          *
  5.803 !           *
  5.901 !            *
  6.000
```

Fig. 1. PRPLOT graph of a function: $y = 3 \exp(-z/3)\cos(4z) + 10$.

```
10      10
15      15
20      20
25      25
30      30
35      35
50      50
80      80


X TITLE? X-AXIS
Y TITLE? Y-AXIS


         Y-AXIS

    10.000                    80.000
          ------------------------------
X 10.000 !*
- 11.166 !
A 12.333 !
X 13.499 !
I 14.666 !
S 15.833 !  *
  16.999 !
  18.166 !
  19.333 !
  20.499 !    *
  21.666 !
  22.833 !
  23.999 !
  25.166 !      *
  26.333 !
  27.499 !
  28.666 !
  29.833 !
  30.999 !        *
  32.166 !
  33.333 !
  34.499 !
  35.666 !          *
  36.833 !
  37.999 !
  39.166 !
  40.333 !
  41.499 !
  42.666 !
  43.833 !
  44.999 !
  46.166 !
  47.333 !
  48.499 !
  49.666 !
  50.833 !                 *
  51.999 !
  53.166 !
  54.333 !
  55.499 !
  56.666 !
  57.833 !
  58.999 !
  60.166 !
  61.333 !
  62.499 !
  63.666 !
  64.833 !
  65.999 !
  67.166 !
  68.333 !
  69.499 !
  70.666 !
  71.833 !
  72.999 !
  74.166 !
  75.333 !
  76.499 !
  77.666 !
  78.833 !                             *
  80.000
```

Fig. 2. PRPLOT graph of a set of data points.

```
0005 DIM T1(60,2)
0010 FOR I=1 TO 60
0020  T1(I,1)=I/10
0030  Z=I/10
0039  Z1=Z/3
0040  T1(I,2)=3*EXP(-1.*Z1)*COS(4*Z)+10
0050 NEXT I
0060  T2=60
0080 INPUT "X TITLE",X$
0090 INPUT "Y TITLE",Y$
0100 GOSUB 9500
0110 END
```

Listing 2.

```
0005 DIM T1(60,2)
0010  T2=0
0020 INPUT X,Y
0030  T2=T2+1
0031  T1(T2,1)=X
0032  T1(T2,2)=Y
0040 IF X<>0 THEN 20
0050 IF Y<>0 THEN 20
0051  T2=T2-1
0055 FOR I=1 TO T2
0060 PRINT #7,T1(I,1),T1(I,2)
0065 NEXT I
0070 PRINT #7:PRINT #7
0080 INPUT "X TITLE",X$
0090 INPUT "Y TITLE",Y$
0100 GOSUB 9500
0110 END
```

Listing 3.

to the maximum or minimum values of y. We see an exponentially decaying sine wave. Also notice that both the x and y axes are labeled.

The second example is the plotting of a series of pairs of data points. Whereas above, we had exactly one data point on each print line, now we may not have data for a given value of x. Listing 3 is a calling routine that will accept a number of data pairs, terminated by a 0,0, place the data into T1, with a count of the number of pairs in T2, and call the plot routine.

Here, both the x and y axes are scaled to their respective maxima and minima. The table of x and y is also printed by the calling routine. The table and plot of a series of eight points where x = y are shown in Fig. 2. You can see that the points as plotted do fall on a straight line, as expected, and fall very near the actual values of x and y.

The program is written for a 16K SWTP 6800 with 8K BASIC version 2.2 and a PR-40 printer on port 7 as the hard-copy device. For a printer on another port, the "PRINT #7,---" statements will have to be changed to reflect your port number. Other BASICs that do not use the port number in their print statements must be modified accordingly. If the machine to be used has an 80- or 132-column printing device, the 30 in statement 9700 should be changed to 70 or 122, respectively. If you desire more than 60 rows, or 60 values of x, then the 60 in statements 9690, 9710, 9766 and the dimension statement should be changed accordingly.

Most people are visual learners; we process information more rapidly through our eyes. The old adage, "A picture is worth a thousand words" certainly applies to data analysis. And until an inexpensive x-y plotter becomes available, this method will draw your pictures. ■

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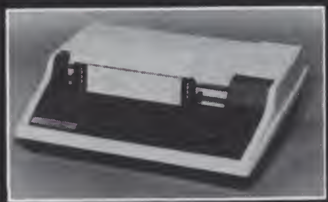

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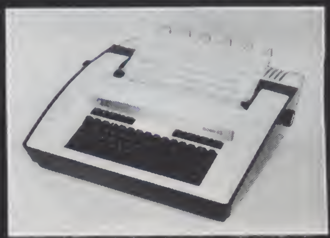

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An Apple a Day Keeps a Kid Occupied

The sines of the father are visited on the son.

Ron Buszta
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Never did I think, when I bought my Apple II, that I would have to fight with my 4½ year-old son for its use. But that's exactly what has happened. My son, Jeffrey, who is still in nursery school, has been inseparable from that machine since I bought it last summer.

He doesn't read yet, but he does recognize some words, such as Jeff, Mom and Dad. I wrote his name on a diskette containing some graphics games so he could identify it when he wanted to play some of those Apple programs. After the first couple of times he played Dragon Maze and Breakout, he wanted to push the diskette into the drive by himself.

He next wanted to start up the Apple from scratch without any assistance from me or from my wife (he's a rather independent youngster!). I explained that it wasn't an easy procedure—you had to turn on the monitor, press the CTRL key down and at the same time press the letter B, repeat the pressing of CTRL and B until the prompt (>) character appeared and, finally, type PR#7 to tell the operating system that the disk was in slot number 7.

I was thoroughly convinced that I had confused the inner workings of his little brain and that he would lose interest and go back to watching Woody Woodpecker cartoons. As I sat down to have myself a good game of Breakout, I heard him say, "Could you show me that again, Daddy?"

He thought he could remember that whole sequence of events and turn on the Apple himself! Realizing he is a very determined little boy, I didn't argue; but I proceeded to tell him again how to communicate with the Apple. After two or three more explanations, Jeffrey had it all but mastered—turn on the Apple, turn on the monitor, press CTRL-B twice and type PR#7. A broad smile crossed his face when he heard the pleasing whirr of the disk drive.

"Now what, Daddy?" he asked. I told him that he couldn't do much more since he couldn't read, but that I would load and run whatever programs he wanted to play. Well, after I did that for a while, naturally he wanted to run the programs. "R-U-N" I would say to him to get a program to run.

It didn't take long until he remembered how to spell RUN or that CTRL-C would stop a program and that the backward arrow would erase a letter that was pressed by mistake.

After a couple of weeks, Jeffrey was typing CATALOG for a list of all the programs on disk (more for the joy of hearing the disk drive run and seeing the pretty red light flash on than for all the info going to the screen) and LIST so he could make all those letters go up the screen. He learned that while playing Dragon Maze, typing R, L, U and D would move the little squiggly character to the right, to the left, up or down in an effort to elude the dragon and gain access to the doorway he guarded. Just remembering what those letters represented, I think, was a great accomplishment and well worth the price of the Apple.

But the learning process for Jeffrey and me did not stop there. While I was learning BASIC from listing programs and from reading the Apple documentation, Jeffrey was learning to recognize RIGHT, LEFT, DOWN, LIST, RUN and CATALOG.

Jeffrey has just turned five years old, and I expect any time now that he'll be teaching me about the SIN and COSINE functions or how to write a program to produce the Fibonacci sequence. ■

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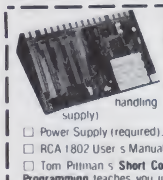

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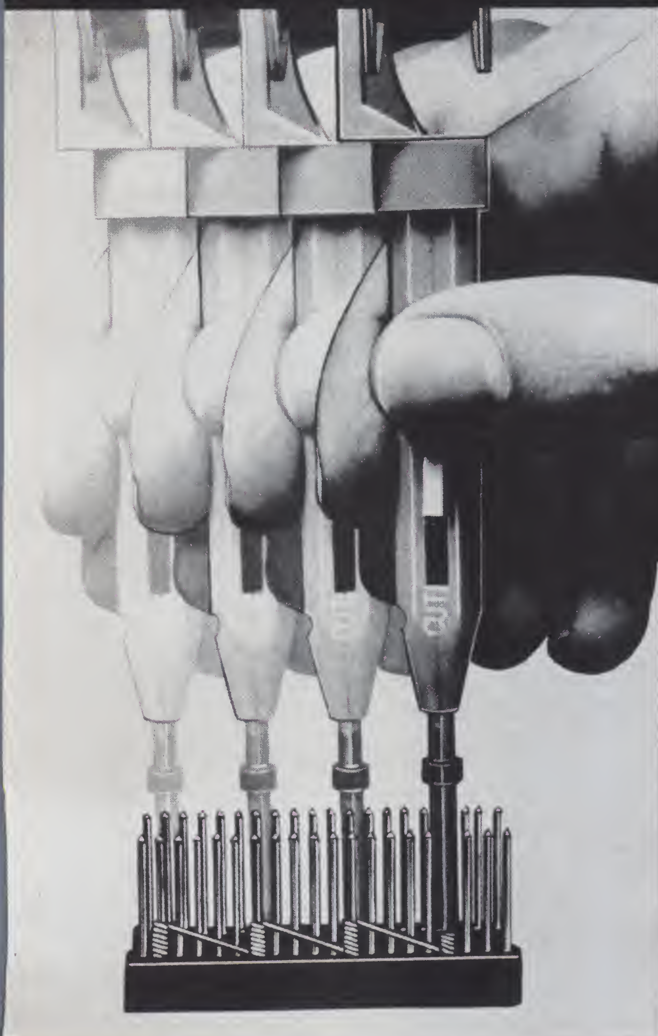

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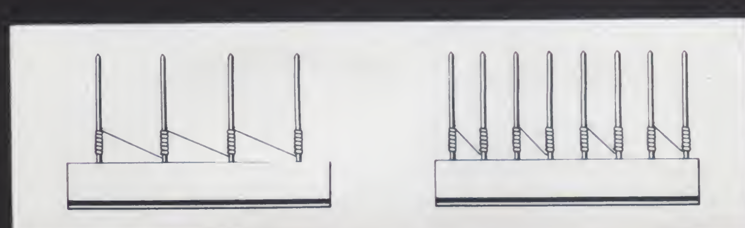

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MPLOT

The plot thickens—then resolves as each plot is normalized to its peak value.

Terry Mayhugh
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Concord TN 37922

One of the more interesting applications for my small computer during the past year in my graduate EE work has been studying the time-step response of various types of compensated negative feedback amplifiers. In order to compare the effects of various

> **"This program has several features that make it simple to use as a called subroutine by another program."**

compensation schemes on the structure of the resultant transient response, it is convenient to plot the data in a standard format with each plot normalized to its peak value.

I wrote MPLOT to accomplish this using a 50 vertical by 100 horizontal point Cartesian coordinate system. This program has several features that make it simple to

```
*
0010 OPTION BASE=0
0020 LINE= 200
0030 DIM X9(101)
0040 DIM Y9(101)
0050 DIGITS= 2
9000 REM : MPLOT
9010 REM : PROGRAM PLOTS DATA FROM X,Y ARRAYS ONTO UNIT NORMALIZED X-Y AXIS
9020 REM : MAX OF 100 POINTS MAY BE PLOTTED ON A 50Y BY 100X PLOT
9030 REM : N9 IS # POINTS TO BE PLOTTED
9040 REM : X9(I) CONTAINS X COORDINATE WHILE Y9(I) CONTAINS CORRESPONDING
9050 REM : Y COORDINATE
9060 REM : DATA MUST BE POSITIVE IN MAGNITUDE
9070 REM : POINTS AT EXTREMA OCCURING IN BORDER ARE NOT PLOTTED
9080 REM : BOTH HORIZONTAL AND VERTICAL ARE NORMALIZED BY THEIR PEAK VALUES
9140 GOSUB 9400
9150 LET M9=1 : REM: Y AXIS ABSOLUTE MAGNITUDE
9160 LET C9=5 : REM: Y AXIS LABELING COUNTER
9170 REM
9180 PRINT
9190 PRINT "NORM. AMP.  1.00 +---------+---------+---------+---------+---------+";
9200 PRINT "---------+---------+---------+---------+---------";
9210 LET C9=C9-1
9220 LET M9=M9-.02
9230 IF C9=4 THEN 9290
9240 IF C9=0 THEN 9330
9250 PRINT TAB(118);"!"
9260 PRINT TAB(18);"!";
9270 GOSUB 9570
9280 GOTO 9210
9290 PRINT TAB(118);"+"
9300 PRINT TAB(18);"!";
9310 GOSUB 9570
9320 GOTO 9210
9330 PRINT TAB(118);"!"
9340 PRINT TAB(13);M9;
9350 PRINT TAB(18);"+";
9360 IF M9=0 THEN 9650
9370 GOSUB 9570
9380 LET C9=5
9390 GOTO 9210
9400 REM : AXIS NORMALIZATION SUBR
9410 LET T9=0
9420 LET Q9=0
9430 FOR I=1 TO N9
9440 IF Y9(I)>Q9 THEN 9460
9450 GOTO 9470
9460 LET Q9=Y9(I)
9470 IF X9(I)>T9 THEN 9490
9480 GOTO 9500
9490 LET T9=X9(I)
9500 NEXT I
9510 FOR 1=1 TO N9
9520 LET Y9(I)=Y9(I)/Q9
9530 LET X9(I)=INT(100*X9(I)/T9+.5)
9540 NEXT I
9550 RETURN
9560 REM : GRAPH SUBR
9570 FOR I=1 TO N9-1
9580 IF ABS(Y9(I))<=ABS(M9+.01) THEN 9600
9590 GOTO 9630
9600 IF ABS(Y9(I))> ABS(M9-.01) THEN 9620
9610 GOTO 9630
9620 PRINT TAB(18+X9(1));"*";
9630 NEXT I
9640 RETURN
9650 PRINT TAB(19);"---------+---------+---------+---------+---------+";
9660 PRINT "---------+---------+---------+---------+---------+"
9670 PRINT "                 0.00      0.10      0.20      0.30      0.40";
9680 PRINT "      0.50      0.60      0.70      0.80      0.90      1.00 ";
9690 PRINT " NORM. TIME"
9700 PRINT
9710 PRINT TAB(18);"ACTUAL Y-AXIS MAXIMUM AMPLITUDE = ";Q9;
9720 PRINT TAB(87);"ACTUAL X-AXIS MAXIMUM TIME = ";T9
9730 END

BASIC
#
```

Program listing.

```
*
0100 PRINT TAB(58);"-UNIT STEP RESPONSE-"
0110 LET N9=100
0120 FOR I=1 TO N9
0130 LET Y9(I)=1.76E-2*EXP(-I/18)*SIN(2*PI*I/28-PI/1.63)+1.73E-2
0140 LET X9(I)=1E-9*I
0150 NEXT I
RUN
```

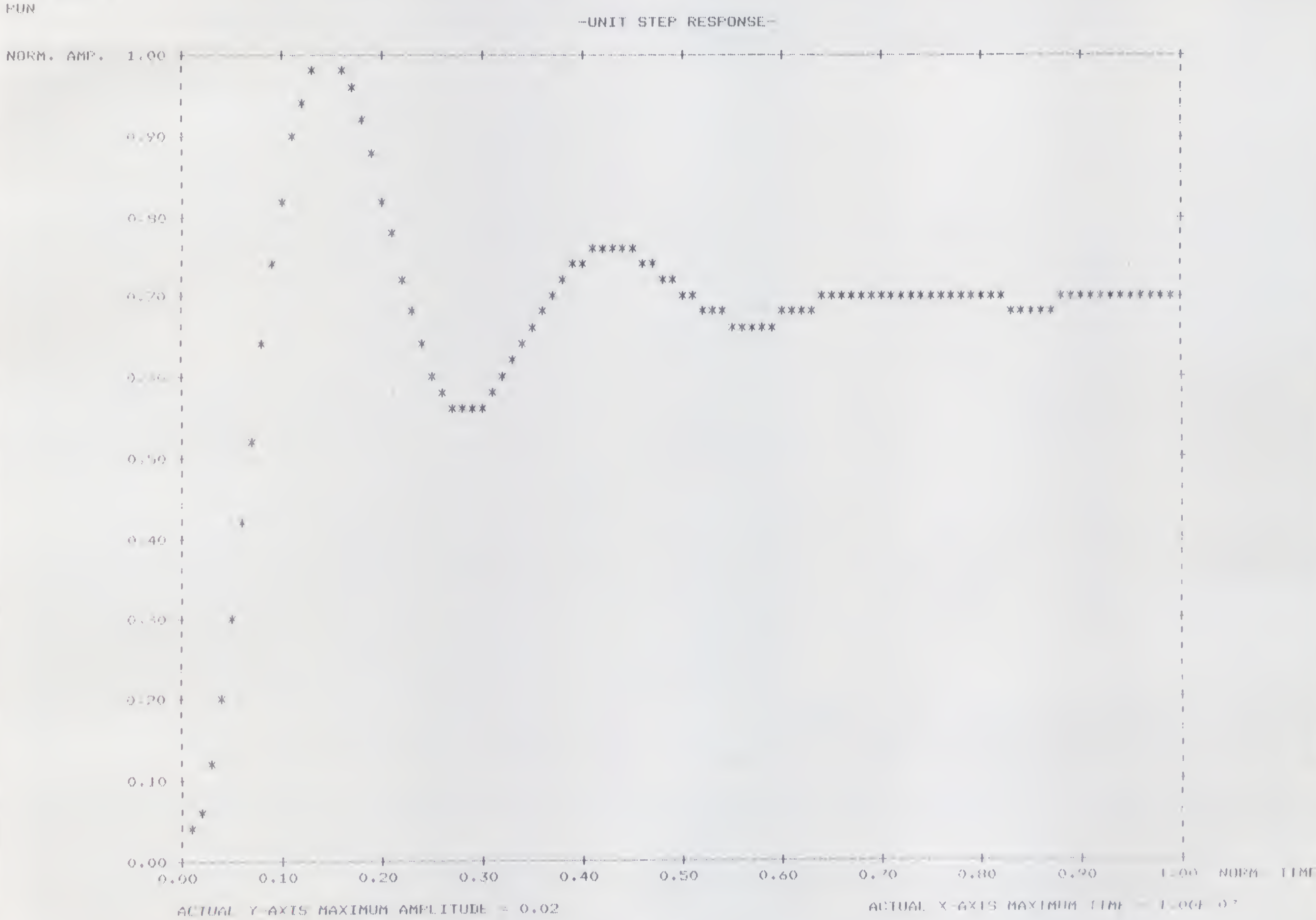

Fig. 1.

use as a called subroutine by another program, and its output format allows quite a bit of information to be obtained from a glance at the result.

The actual program (see listing) resides between lines 9000 and 9730 so that it can be easily appended to the end of a control program. Before calling this routine, the user or the control program must define the number (N9) of points to be plotted and place the data to be plotted into two single-dimension arrays, X9(I) and Y9(I). The horizontal coordinate *must be present* in the X9(I) array, and its corresponding vertical ordinate must reside in the Y9(I) array.

The only plotting restriction is that the data in these arrays must be greater than zero. Negative entries must have their signs stripped by an ABS statement, since the program is capable of plotting magnitudes only.

MPLOT internally normalizes the data before plotting it by dividing the magnitudes of all vertical ordinates by the magnitude of the greatest vertical ordinate, and similarly for the horizontal axis. The actual peak vertical and horizontal amplitudes are printed for reference at the bottom of the plot. However, since these points lie in the borders of the graph, they are not actually plotted; but in most cases, this is not important since they are easily extrapolated.

MPLOT was written in Smoke Signal Broadcasting BASIC, version 6.0, on an SWTP 6800/2 operating under SSB's BFD 68/2 disk hardware and DOS 68.31. The output is routed to an LA36, but any printer with 132-column capability may be used. In this system this program requires less than 2K bytes for storage plus about 1.3K bytes for variables. A few statements in the following listing indigenous to SSB BASIC may require some explanation.

Line = 200 at the beginning of the program is required to maintain full control of the print head over the entire page and is not required by many other BASICs. The DIGITS = 2 statement sets the printing format so that only two digits to the right of the decimal will appear on all printed numerics. A PRINT USING statement can be used to accomplish the same thing. Of course, if this program is used as a subroutine by another calling program, don't forget to replace the END statement with RETURN.

The simple example in Fig. 1 shows the format of the output. Lines 110 through 150 calculate the elements of arrays X9(I) and Y9(I). In this case, the X9(I) represents discrete intervals of time, while the Y9(I) is the sinusoidal response of an underdamped second-order system. Pertinent quantities such as rise time, overshoot and setting time are easily obtained from the final graph. ■

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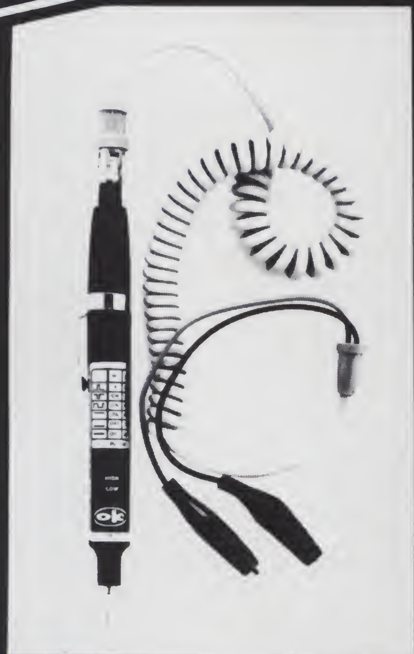

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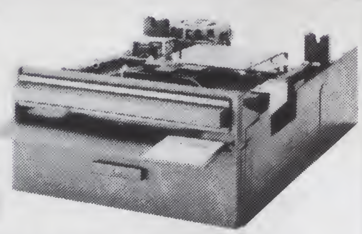

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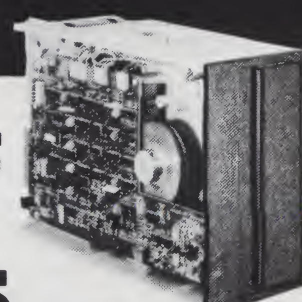

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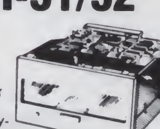

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Most programs used with personal computers such as the Apple II use only a fraction of the total available RAM memory. For example, a fairly long "Pong" game program listed in the Apple II manual occupies about 14 percent of the available space in a 16K machine. Since this is true, why not use the other 85 percent for additional game programs? If this were done, the hassle of reading in programs from tape would be reduced severalfold.

The Procedure

For Apple II owners, there is a way of stacking many programs into memory and arranging them so that any one can be called with a simple RUN command. The procedure outlined below requires some simple hexadecimal arithmetic and close attention to sequence; however, the sample log sheet simplifies these bookkeeping chores.

To learn how the procedure works, follow these step-by-step instructions.

1. Load Program A. This program will develop into an index record as the system grows. It includes TEXT and CLEAR statements and, for the purpose of demonstration, a tone generation POKE routine copied from the Apple II manual. After it has been loaded, you can check it by running it and then entering a CALL 2 command. If the program is correct, a single beep tone will be heard.

Now refer to Fig. 1 and follow along with a blank copy of the log sheet. First pencil in the title of Program A, which we shall call INDEX.

2. Write in the first line number of the program (0).

3. Write in the last line number on line 3 (99).

Instructions 4 through 8 do not apply to this initial program; they will be left blank.

9. Press the reset key on your Apple to get into the *MONITOR mode and type in *CB and *CA with a return after each and record the contents of these memory addresses in the spaces provided. If Program A is entered exactly as listed, the contents will be 3F2D.

10. Subtract this number from 4000_{16} to determine the length of Program A. Note that 4000_{16} only applies to a 16K machine. For a 4K machine, the subtraction would be from 1000_{16}. Place the result of this calculation (00D3) in the spaces provided.

11. Transfer the hex address on line 9 to line 11 as indicated by the arrows and, with the Apple still in the *MONITOR mode, tape a machine-language copy of the program with the command: •3F2D.3FFFW.

This machine-language copy is only used when new programs are added to the master file, so it can be located somewhere other than at the beginning of a tape. I record this copy at location 50 on my counter-equipped recorder.

12. Reenter BASIC mode with a Control C and SAVE Program A at the beginning of a tape. Make a check mark in the space provided to indicate that this step has been completed.

Now we are ready to stack our second program. Since the first program ended with line 99, the second program can start at line 100. Push the reset key and reenter BASIC with a Control B command, then load Program B. If the computer hasn't been turned off since the first program was entered, a RUN command will result in a tuneful(?) rendition of "Under the Shade of the Old Apple Tree."

Get out the log sheet copy and follow the steps below line-by-line as before. See Fig. 2.

1, 2 and 3. Log in the program name and first and last line numbers of the program (Program B) as done with the previous program (Program A).

4. Press the reset key to revert to the *MONITOR mode and determine the contents of memory locations *CB and *CA. This number is the hex address of the *bottom* of the new program. Place it in the first two spaces in line 4. Subtract 1 from this hex number and put the result in the last two spaces on line 4: $3E11_{16} - 1 = 3E10_{16}$.

5. Transfer the master length on line 10 of the previous log sheet to line 5 and subtract this hex number from the one directly above and enter the difference on line 6.

$$3E11_{16} - 00D3_{16} = 3D3E_{16}$$

6. Locate the machine-language tape of the previous program (Program A) and •read it into memory with the command: •3D3E.3E1OR.

7. Insert the address of the bottom end of the combined

```
 1.  PROGRAM NAME ______________________________
 2.  FIRST LINE NO. ____
 3.  LAST LINE NO. ____
 4.  *CB   *CA               __  __  - 1 =  __  __
 5.  LESS MASTER LENGTH    - __  __          ↓   ↓
 6.  *READ IN MASTER         __  __    .    __  __ R
 7.  *ENTER                  CB:  CA:
 8.  >INSERT (        ) PRINT"FIRST LINE NO. & PROGRAM NAME"
 9.  *CB   *CA (NEW)         __  __
10.  MASTER LENGTH (NEW)     ↓   ↓          __  __
       4000₁₆ - *CB CA(NEW)
11.  *WRITE NEW MASTER       __  __  .      3FFFW
12.  >SAVE NEW MASTER              (   )
```

```
 1.  PROGRAM NAME    INDEX
 2.  FIRST LINE NO.  0
 3.  LAST LINE NO.  99
 4.  *CB   *CA               __  __  - 1 =  __  __
 5.  LESS MASTER LENGTH    - __  __          ↓   ↓
 6.  *READ IN MASTER         __  __    .    __  __ R
 7.  *ENTER                  CB:  CA:
 8.  >INSERT (        ) PRINT"FIRST LINE NO. & PROGRAM NAME"
 9.  *CB   *CA (NEW)         3F  2D
10.  MASTER LENGTH (NEW)     ↓   ↓          00  D3
       4000₁₆ - *CB CA(NEW)
11.  *WRITE NEW MASTER       3F  2D  .      3FFFW
12.  >SAVE NEW MASTER              (✓)
```

Fig. 1. Blank program stacking log and completed log for INDEX.

```
0 TEXT:CALL -936:POKE 0,64:POKE 1,100
97 POKE 2,173:POKE 3,48:POKE 4,192:POKE 5,136:
   POKE 6,208:POKE 7,4:POKE 8,198:POKE 9,1:
   POKE 10,240
98 POKE 11,8:POKE 12,202:POKE 13,208:POKE 14,246:
   POKE 15,166:POKE 16,0:POKE 17,76:POKE 18,2:
   POKE 19,0:POKE 20,96
99 END
```

Program A.

```
100 POKE 0,128:POKE 1,100:CALL 2
105 POKE 0,121:POKE 1,100:CALL 2
110 POKE 0,108:POKE 1,200:CALL 2
115 POKE 0,114:POKE 1,200:CALL 2
120 POKE 0,108:POKE 1,200:CALL 2
125 POKE 0,96:POKE 1,200:CALL 2
130 POKE 0,108:POKE 1,200:CALL 2
135 POKE 0,161:POKE 1,100:CALL 2
140 POKE 0,128:POKE 1,150:CALL 2:CALL 2
142 FOR K=1 TO 300:NEXT K
145 POKE 0,161:POKE 1,100:CALL 2
150 POKE 0,144:POKE 1,100:CALL 2
155 POKE 0,128:POKE 1,200:CALL 2
160 POKE 0,137:POKE 1,200:CALL 2
165 POKE 0,128:POKE 1,200:CALL 2
170 POKE 0,122:POKE 1,200:CALL 2
175 POKE 0,128:POKE 1,200:CALL 2
180 POKE 0,215:POKE 1,200:CALL 2
185 POKE 0,161:POKE 1,250:CALL 2
190 END
```

Program B.

program into memory locations *CB and *CA as follows:

*CB:3D Return
*CA:3E Return

8. Reenter BASIC mode with a Control C and insert the following index line:

10 PRINT "100 APPLE TUNE"

Write in the line number of the foregoing insertion in the space provided in line 8.

9. Return to *MONITOR mode by pressing the reset key and then determine the contents of memory locations *CB and *CA. Log these numbers on line 9.

10. Calculate the new master program length by subtracting line 9 from 4000_{16} and log the result.

$4000_{16} - 3D28_{16} = 02D8_{16}$

11. Make a machine-language copy of the master program with the command *3D28.-3FFFW just as was done with the first Program A.

12. Return to BASIC mode with a Control C and SAVE a copy of the new master program.

Recording steps 11 and 12 can be accomplished by taping *right over* the previous program copies.

If everything has been done correctly, typing in a RUN command will clear the screen and the index and title of the first operating program in the stack will appear:

100 APPLE TUNE

It can be accessed by typing in a RUN 100 command.

This stacking procedure can be continued until the master length on line 10 approaches 3800_{16} (for 16K). Of course, some space in memory must be reserved for memory allocations specified through DIM statements and for storage of the values of variables.

Precautionary Remarks

Each new program must start with a line number larger than the last line of the prior program in the index.

If any changes are made to programs already in the index, the length of the master program must be recalculated and a new machine-language copy made.

It is good practice to have an END statement on the last line of each program entered. Use a GOTO or an IF-THEN statement on a prior line to merge programs.

Line numbers of programs copied from other sources must be renumbered and all GOTO and THEN references adjusted.

Some advantages of this procedure are that subroutines like that in Program A in this example are accessible to all the programs in the index (see Table 1). Similarly, if the computer has not been turned off, data entered through one program is available to others in the index.

I like to group programs by type, but it is a good idea to have one tape with as many different programs as possible for demonstration purposes. It is a convenient and impressive way to show off the tremendous capability of the Apple II.

The master program that I developed while working up this procedure has the index shown in Table 1. If some of the titles look familiar, it is because I was looking for programs to load, and these were conveniently available in Apple reference manuals. All of this occupies about 50 percent of memory. ■

100	TEST PROGRAM
110	PLOT DOTS AT CORNERS
130	RANDOM DOTS ON SCREEN
170	ALTERNATING SOLID COLORS
230	DRAWS RANDOM QUILTED SQUARES
300	DIAGONAL X'S
350	APPLE PATTERN
450	PUT A HORSE ON THE SCREEN
550	ROD'S COLOR PATTERN
650	TONE SUBROUTINE
750	COLOR SKETCH (REQUIRES X-Y PADDLES)
900	PONG GAME (REQUIRES PADDLES)
1200	STRING EXERCISE
1490	PRIME NUMBER GENERATOR
2000	CLOCK SIMULATION
2100	PRIME FACTORS OF INTEGERS TO 32760

Table 1. Program index.

```
1.  PROGRAM NAME ____________
2.  FIRST LINE NO. ___
3.  LAST LINE NO. ___
4.  *CB  *CA                    __  __  -1 =
5.  LESS MASTER LENGTH        - __  __         ↓    ↓
6.  *READ IN MASTER             __  __   .    __   __ R
7.  *ENTER                      CB: CA:
8.  >INSERT (      ) PRINT"FIRST LINE NO. & PROGRAM NAME"
9.  *CB  *CA (NEW)
10. MASTER LENGTH (NEW)         ↓   ↓         __   __
      4000₁₆ - *CB CA(NEW)
11. *WRITE NEW MASTER           __  __   .    3FFFW
12. >SAVE NEW MASTER                    (  )
```

```
1.  PROGRAM NAME  APPLE TUNE
2.  FIRST LINE NO. 100
3.  LAST LINE NO. 190
4.  *CB  *CA                    3E  11  -1 =  3E   10
5.  LESS MASTER LENGTH        - 00  D3         ↓    ↓
6.  *READ IN MASTER             3D  3E   .    3E   10 R
7.  *ENTER                      CB: CA:
8.  >INSERT (  10  ) PRINT"FIRST LINE NO. & PROGRAM NAME"
9.  *CB  *CA (NEW)              3D  28
10. MASTER LENGTH (NEW)         ↓   ↓         02   D8
      4000₁₆ - *CB CA(NEW)
11. *WRITE NEW MASTER           3D  28   .    3FFFW
12. >SAVE NEW MASTER                    (✓)
```

Fig. 2. Blank program log and completed log for Apple Tune.

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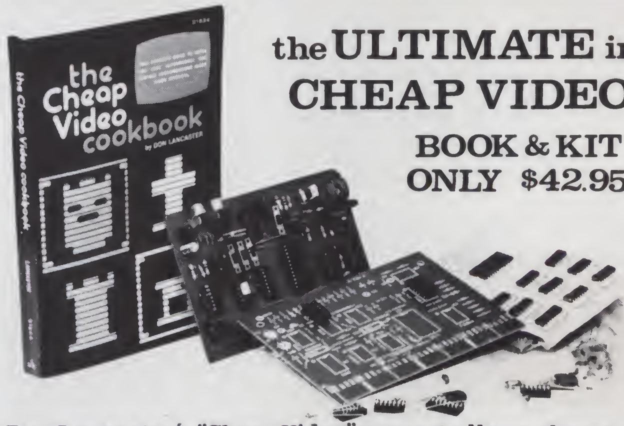

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✓ Reader Service—see page 227

Cablery Isn't Dead

The most sophisticated computer is useless without reliable interconnecting cables.

James M. Hansen
Methodist Hill
Lebanon NH 03766

It's a strange world. Many people own computers; a lot use them; and quite a few can even program them effectively. Yet, most computer users would have trouble making a reliable cable to connect their terminal and computer. This harsh reality is disconcerting, particularly when we consider that cables and the technology for making them have been around for about a century. Yet our computers, which were only a glint in the eyes of R and D folks 10 years ago, and undreamed of 100 years ago, utterly depend on reliable interconnecting cables to operate.

For most of us, Cinch Jones D connectors represent a best buy. These are good quality, reliable and easily obtained connectors. They come in a variety of sizes, ranging from nine pins to as many as 50. They are probably most familiar in the 25-pin configuration where they are used on acoustic couplers, modems, terminals and computer ports using the RS-232 interface standard (also called the EIA interface). While not the least expensive connectors around, they are moderately priced, especially on a pins/dollar basis. They are easily damaged by poor solder technique, and herein lies my tale.

For demonstration purposes, and clear photography, the following illustrations show how a single wire is soldered onto a pin. Careful attention to detail will allow you to solder a whole cable using the same approach. It is not difficult, and anyone with the dexterity of a tree sloth or better should be able to make a good, reliable cable . . . if you follow these guidelines to the letter.

Guidelines

First, you must have the proper tools. These include a properly adjusted wire stripper, a pair of miniature side cutters, a soldering iron, a small bench vice, good light and solder. Wire strippers may be a good set of incisors, strong fingernails or, as I prefer, a commonly available plain yellow-handled tool, which works well, but only if you take the time to carefully adjust it so it does not nick the wire. Miniature side cutters are preferred, since you will occasionally want to prune around the connector pins after the cable is completed. Klein makes particularly good ones.

Use a small, low-wattage soldering iron! If you do not have access to a temperature-controlled soldering iron or a 15 Watt pencil, you run serious risks when soldering to these connectors. It would amaze you what a 250-Watt American Black Beauty can do to an innocent D connector. You do not need a big iron! Your bench vice is another key to making good cables. One with about two-inch jaws is right.

Also be sure you use a good grade of solder . . . rosin core, if you please. Use small-diameter solder such as is sold at electronics suppliers. Hardware store varieties tend to have larger diameters and inconsistent flux content. This makes it hard to get just the right amount of solder. If flux is thin, the solder won't flow properly; when there is too much flux, it will run down the connector pins, possibly contaminating them, and produce black guck all over them.

Make sure you have enough light to see by. A 60-Watt light bulb ten feet from your bench is not enough. My preference is a dual 40-Watt fluorescent shop light about three feet above the

Photo 1. After stripping about 3/8 inch of insulation from each wire, apply an even coating of solder.

Photo 2. Clip off the wires, leaving about 1/8 inch of bare wire. When the wire is inserted into the connector, the insulation should be flush with the top of the connector pin.

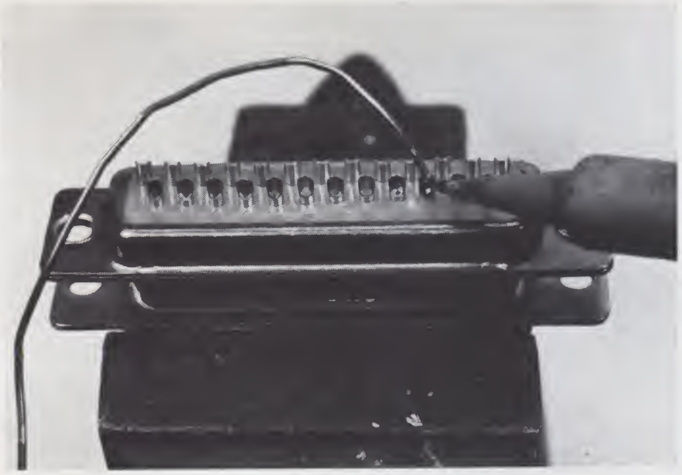

Photo 3. Tin each connector pin to be used. Solder should just fill the bottom of the solder pot.

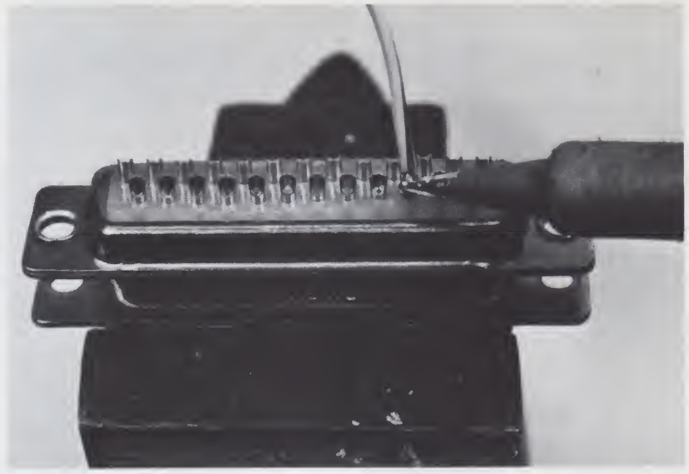

Photo 4. Insert the wire into the connector. Avoid excessive and prolonged heat to prevent damage to the connector.

bench. You cannot do good work if you cannot see, or if there are shadows from your tools or hands over your work. Shop lights are inexpensive, usually $12-$15 on sale, and easy to install, and they make life much more livable. Once all your tools are ready, it is time to begin.

Soldering the Wire

Our first order of business is to strip the wires to be connected. You should remove about 3/8 inch of insulation from the ends of each wire to be connected. Be careful not to disturb the individual strands; leave them in their tightly woven form. The reason we take so much insulation off is to ensure that there will be about 1/8 inch of undisturbed wire near the insulation end.

Next, tin the wire (see Photo 1). Be sure to wipe the tip of your iron on a damp sponge to clean it first. Then put a little dab of solder on its tip to start heat transfer into the wire as quickly as possible. Place the tip on the wire near the insulation end of the wire and run it out to the end, adding solder as you go. A properly tinned wire will have solder throughout the strands, and no individual strands will be clearly visible. There may be a little ball or whisker at the end where the iron left the wire. Photo 2 shows how this ball is removed—we cut all but 1/8 inch of the tinned wire off.

After you have prepared all the wires in your cable as outlined above, the next step is to ready the connector. The body of the connector is made out of nylon or some similar material and is easily damaged by heat. For this reason, a good safety precaution is to plug a mating connector into the one you are wiring. This helps dissipate heat and hold the pins in alignment if you become a little heavy-handed with the iron. Put the connector pair into your vice.

Photo 3 shows how each connector pin to be wired is tinned. To do this, you first clean your iron on a damp sponge as before, then put a little dab of solder on its tip. Place the tip on the inside edge of the connector solder pot and add a little solder, just enough to fill the bottom of the pot. *Do not fill the pot to the top!* If you do, the excess solder will spill when you insert the wire, making a mess of things. The pin just to the left of the iron in Photo 3 is shown as it should be when properly tinned.

And now for the coup de grace: putting the wire into the connector terminals. This is where the bench vice really pays off. Take the correct wire in one hand and the soldering iron in the other. Wipe the iron clean (again) and place it on the edge of the solder pot, just as you did when tinning it.

The solder in the connector will usually make one bubble when thoroughly melted. This is your cue to push—in one deft motion, if possible—the tinned end of the wire into the connector at about a 45–60 degree angle, then raise it vertically, gently pushing it down until the insulation is flush with the top of the back skirt of the connector. Remove the soldering iron immediately and hold things still while the solder hardens. The insertion of the wire should take less than a second, the whole operation no more than three seconds. Photo 4 shows the final seconds of the procedure, just before the soldering iron is removed.

If you are wiring multiple conductors, you will find it useful to pre-bend each wire to be soldered so it will go into the connector with a minimum of strain.

Final Thoughts

1. If you plan to put a cover (termed hood) on these connectors, and you are using a multiconductor cable, the outer sheath or insulation should be cut back from the ends of the stripped and tinned wires no more than about 3/4 inch. If you cut it back further, the individual wires will show outside the hood and look as if some amateur did it. Unless you are really good, there is no sense in broadcasting your level of achievement.

2. Never, ever use solid wire for your cabling unless it is stapled to the wall and a connector rigidly mounted to the wall is used. Solid wire will do for a while, but it is easily nicked when stripping, and even when not damaged, it will eventually fracture where it meets the solder. This failure will occur at an inopportune time. Telephone wire is great for telephones and stereos, but not for computers.

3. Do you have trouble counting the pins on these connectors? There is no reason to if you have good light. Each pin is labeled on both the front and back of the connector, and if you position it and your light just right, you should have no trouble reading it. Fig. 1 gives a pin-out for the solder side of both the male and female connectors.■

Fig. 1. Pin layout for the 25-pin D connector. The covers—usually called hoods—for these connectors are Cinch DB-51226-1. The special nuts that are sometimes used on modems and acoustical couplers to screw the cable connector in place are called screw lock assemblies, Cinch part number D-20419.

DEALER DIRECTORY

REVIEWS

(from page 22)

to the microcomputer field but aren't sure that they have the "savvy" to talk their school boards into it.

Bringing some teaching theory into her writing, Doerr starts with good examples and outlines variations of each theme. As with most books of this nature, this one begins with a short history of computers, but gives a relatively well-balanced discussion of the whys and, more important, the why nots of getting into a school computer program. In almost every example Doerr gives, she discusses capabilities, shortcomings and the variations among systems that might affect the topic under discussion.

She devotes one chapter each to computer science applications, problem solving, instructional simulation, games, CAI and administrative uses. In many cases, she provides PET BASIC program listings and shows the evolution of those programs from very simple to increasingly complex.

The "nuts and bolts" of using microcomputers in the school environment are included. Doerr writes about physical considerations: how to supervise the equipment, what to provide for user space, how to keep it from being ripped off, how to deal with "moss-bound" colleagues and channeling student enthusiasm.

A useful section in the book is the suggested course outline for teaching about microcomputers and BASIC. Doerr organizes a course that will spark student interest and take students step-by-step through a microcomputer system, including developing and evaluating equipment operation and writing software. A minor omission is failing to warn teachers to write-protect their tapes before placing them in students' hands. The best feature of the book is the great example programs for various curricula.

The last sections comprise annotated sources for further information and a brief description of some of the systems presently suitable for the educational market.

I would have liked to see more on the disadvantages of various systems and documentation problems, especially as they relate to school use. While many readers of computer literature know of those problems in terms of service and documentation, these topics received short shrift in a book that is likely to be one of the few sources of guidance to some teachers.

This is a valuable book for educators—it will open the Doerr for many who want to get a micro into the classroom.

Paul W. Marsh
Bozeman MT

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Classified advertisements are intended for use by persons desiring to buy, sell or trade used computer equipment. No commercial ads are accepted.

Two sizes of ads are available. The $5 box allows up to 5 lines of about 35 characters per line, including spaces and punctuation. The $10 box allows up to 10 lines. Minimize use of capital letters to save space. No special layouts allowed. Payment is required in advance with ad copy. We cannot bill or accept credit.

Advertising text and payment must reach us 60 days in advance of publication (i.e., copy for March issue, mailed in February, must be here by Jan. 1). The publisher reserves the right to refuse questionable or inapplicable advertisements. Mail copy with payment to: **Classifieds, Kilobaud Microcomputing, Peterborough NH 03458**. Do not include any other material with your ad as it may be delayed.

For Sale: Cybernetics 16 × 32 video interface, $85; Shugart 8" disk drive (new), $250; 16K SWTP 6800 computer w/spare chips, $495; PDP8F multi-user—8K core, $1350; .5-30 MHz Lafayette rec., $35; Simpson 5" scope, $65; Ten Tec 570 (100 Watt) xcvr., $240; Shure M615 freq. anaz., $185 & SR107 freq. eq., $125. T. George, 108 Clark St., Vestal NY 13850. (607) 785-7085.

Sell—3 yrs of Kilobaud—77-78-79, $100, 1 ship. Also other books and mags; Byte, Interface Age, etc. Write for list. Andy Thornburg, RR2, Thompsonville IL 62890. Phone (618) 627-2166.

Sell: Intertec Intertube, latest version, like new, manual, schematics, $690. Teletype 33KSR also like new set up on 20 mA, $385. Call Vic, 325 Wilson Ave., Westwood NJ 07675. (201) 664-6833.

Viatron 21s for sale (2), robot printer (1). $500 for 3 units. Also SWTP 6800 and CT1024, $250. G. Ludwig, Box 408, Rice Lake WI 54868. Phone (715) 234-2680.

S-100 memory: two Processor Tech 16K dynamic RAM boards #16KRA for SOL or any S-100 system. Transparent refresh. 32K for $200. Manual. B. Duke, 13526 Pyramid, Dallas TX 75234.

For Sale: PDP 1105, 16K core + 12K semiconductor memory, DL 11 interface. Sold to highest bidder before February 15, 1980. Contact: M. F. Johnson, Washington University School of Medicine Library, 4580 Scott Ave., St. Louis MO 63110. (314) 454-3711.

Digital Group Z-80 w/10K, I/O, TVC-64, monitor, keyboard plus extras. All in DG cabinets. $700. Paul Mayo, 2409 Ocean Pkway, Brooklyn NY 11235. (212) 646-7725.

Wanted: Software for S-100. Particularly specialized for business data bases and similar applications. Modification programming assistance in NYC metropolitan area is solicited. (212) 867-5650.

SWTPC 6800, 28K, AC-30, complete documentation, 8K BASIC tape, 6800 programming manual. 1 year old. $695 or best offer. MM Computer Club, 333-75th Street, Downers Grove IL 60515.

For Sale: Digital Group system, 50K static, dual 8" Shugarts, B printer, 9" monitor, keyboard, PROM disable board, CP/M, OASIS 5.3, OBASIC, SCRIPT, over 10 diskettes of utilities. All systems boot from a single PROM. All dress cabinets—$5000. Ray Martin, 4614 Trail Crest Cir., Austin TX 78735. (512) 892-0156.

CALENDAR

San Francisco CA

The 5th West Coast Computer Faire will be held in San Francisco's Civic Auditorium & Brooks Hall, March 14–16. Last year over 14,000 people took advantage of the over 330 exhibits and over 100 speakers. For information, contact Computer Faire, 333 Swett Rd, Woodside CA 94062. (415) 851-7075.

Philadelphia PA

The fifth Produx 2000 will be held May 21–23 at the Philadelphia Civic Center. This is a sales-oriented exposition of business products and personal and business computers. For information, contact Produx 2000, Inc. (215) 457-2300.

Moodus CT

A computer camp for youngsters 10 to 17 years of age will be directed by Dr. Michael Zabinski, Prof. at Fairfield U. The camp is planned for June 29th to July 4th, and the campers will have small-group instruction with hands-on experience with mini and microcomputers. Recreational facilities will also be available. For information, contact Michael Zabinski, Ph.D., at (203) 795-9069, or write: Computer Camp, Grand View Lodge, Box 22, Moodus CT 06469.

CORRECTIONS

The upper chip in Fig. 1 of "The Sorcerer Connection" (August 1979, p. 84) should be labeled C2A74123, not 74125.

The accompanying changes should be made to the "NAVPROG" program (February 1980, p. 25). The last line before the "Magnetic Course" heading, and the first line after it, should be changed to read 1300–1350, not 1300–1400.

```
01300 REM FIND MAG.CRS.
01310 V1=(V(I)+V(I+1))/2
01320 V1=FN S6(V1)
01330 Y(I)=T(I)+V1
01340 IF Y(I)>360THEN Y(I)=Y(I)-360:GOTO 1500
01350 IF Y(I)<=0THEN Y(I)=360-Y(I)
01500 REM GET AVG.WIND VECT.
01510 IF S(I)=0AND S(I+1)=0THEN R2=0:Q(I)=T(I):GOTO 2010
        .
        .
       ETC

01570 X=W4-W3:S1=S3*S3:S2=S4*S4
01580 IF X=0THEN R2=(S3+S4)/2:Q(I)=W3:GOTO 2010
01590 IF X=180THEN R2=0:Q(I)=T(I):GOTO 2010
01600 X3=0:IF X>180THEN X3=1:X=360-X
01610 R=SQR(S1+S2-2*S3*S4*COS(X/U))
01620 Q=(S2+R*R-S1)/(2*S4*R)
01630 R2=SQR((S2+(R/2)*(R/2))-2*S4*(R/2)*Q)
01640 X1=(S2+R2*R2-(R/2)*(R/2))/(2*S4*R2)
01650 X1=ATN(SQR(1-X1*X1)/X1)*U
01660 IF X3=1THEN X3=0:Q(I)=W4+X1:GOTO 1680
01670 Q(I)=W4-X1:GOTO 2010
01680 IF Q(I)>360THEN Q(I)=Q(I)-360
02010 W=ABS(T(I)-Q(I))
        .
        .
       ETC
```

San Diego CA

The San Diego Computer Society is sponsoring a computer fair at the Scottish Rite Temple, 1895 Camino Del Rio South, on Saturday, April 12, 1980. In addition to exhibits, there will be presentations and an awards dinner with Adam Osborne as featured speaker. For information, contact Richard Lindberg, PO Box 81537, San Diego CA 92138, or call (714) 455-1210 evenings.

Trenton NJ

The fifth annual Trenton Computer Festival will run April 19–20 with a 5-acre outdoor flea market and indoor commercial exhibitor area. There will be 30 speakers, user group sessions and demonstrations. Computer conference sessions and forums will be held on microcomputers in the home, education, medicine, amateur radio, music and the arts. There will be a Saturday night banquet. TCF-80 will be held at Trenton State College, just outside of Trenton NJ. For information, contact Dr. Allen Katz, Trenton State College, Hillwood Lakes, PO Box 940, Trenton NJ 08625. (609) 771-2487.

NYC and San Francisco

The spring schedule of the Computer Science Education Extension is:

"Principles of Database Systems," Prof. J. D. Ullman of Stanford U., New York City, March 24–27; San Francisco, June 16–18.

"Computer Picture Processing and Graphics," Prof. T. Pavlidis of Princeton U., New York City, June 2–4.

"Programming in PASCAL," Drs. V. Ledin and J. Faletti of U. of C.–Berkeley, San Francisco, March 24–28.

"Principles of Compiler Design," Prof. J. D. Ullman of Stanford U., New York City, June 25–27.

"Programming in PASCAL," a special two-day course in Los Angeles, May 18–19, prior to the NCC.

For more information, write to Computer Science Education Extension, Computer Science Press, Inc., 9125 Fall River Lane, Potomac MD 20854.

Hal T. Gordon
University of CA, Berkeley
Berkeley CA 94720

Instruction Sets Examined and Compared

Ever wonder how the 8080, Z-80, 6800, 6502 and 2650 differ from each other? Some observations about this question resulted from research that went into the following article.

The capability of a microcomputer system largely resides in the instruction set of its CPU chip, although support chips, peripherals and skillful programming are needed for the full realization of this capability. Even users who program only in high-level languages ultimately rely on the power of an instruction set, since the interpreter or compiler programs they need must be written in the machine language of a specific microprocessor.

In volume II of his *Introduction to Microcomputers*, Adam Osborne presents detailed summaries of the instruction sets of many microprocessor designs, and three articles by Lance Leventhal in *Kilobaud* (July, August and September 1977) contain useful discussion of sets at a more general level. It seems to me that none of these ever quite comes to grips with the question: What is it that makes one set more or less versatile than another?

Although Osborne encodes a simple benchmark program in each of many sets, he rightly stresses that this is not an adequate criterion for overall evaluation. If this were done for a much larger and more diverse set of test programs (including complex ones), you would have empirical criteria of capability: (1) Which instruction set encodes them (on the average) with the fewest program bytes? (2) Which runs fastest? (3) Which requires the least programming and debugging time?

"People have favorite friends, books, tools and games. Using an instruction set is very much like playing a game."

Since all these criteria are highly dependent on programming expertise, they ought to be first measured for a group of experts (to estimate the true potential of each set) and then for a group of amateurs (to estimate performance at the user level). It is unlikely that this objective testing will ever be done. All we shall have to go by are the claims of the manufacturers of CPUs and systems, and the more-or-less educated guesses of experts (who are not always in agreement).

This article is a nonexpert view, based on a longstanding fascination with instruction sets. I look upon these as intellectual works of art that reflect not merely the technical experience but the imagination and personality of their creators.

Before going on, I should answer two questions. First, do the differences between instruction sets *really* lead to significant differences in performance? Unquestionably they do, but — since performance is a complex concept, and each design has its unique strengths, and the instruction set is by no means the *only* design element that determines performance — we cannot easily rank chips in order of performance. There is one exception: The Z-80 will *always* perform as well as or better than the 8080.

Second, do I have a personal bias? Yes, I prefer the simplicity of the 6502. This does not mean that this set is the "best" or that I am unable to appreciate others (the Z-80 is certainly more capable) or that I think everyone should react as I do. On the contrary, many users will find other sets more attractive. People have favorite friends, books, tools and games. Using an instruction set is very much like playing a game.

Many different designs exist. *All* can do *everything*, and do it very well. In such circumstances, the fact that one may excel the others in many ways ceases to be an *overriding* consideration, and subjective factors (hard to explain to a computer!) can enter in. If power were the sole determinant, the PDP-8 mini would have vanished when the PDP-11 was created, and the Z-80 would by now have obliterated the 8080. I expected this to happen, not realizing that if

you have all the capability you need, why bother to get more?

Instruction Op Codes

When the control unit of a CPU "reads" an instruction operation code from a program, it copies its bit-pattern into its *control register*. There, it triggers a complex logic-network of gates, causing specific, planned modifications of the bit-pattern in one or more on-chip registers and/or external memory locations. On-chip operations run at lightning speed (propagation delays measured in nanoseconds). Communication with external locations, enabled by a clock signal, is slower because the bus lines have longer paths and higher capacitances.

Although the number of *possible* operations encodable in logic-networks is extremely large, there is a practical limit to the number that can be fitted into one LSI chip. Every microprocessor designer gives much thought to selecting only the ones he believes will be very useful.

Another design goal is to have one-byte op codes (of which, with eight bits, there can be no more than 256) to minimize the time involved in accessing program memory. Most existing designs do not use all the 256 possible eight-bit patterns as op codes (the 8080 uses 244, the 6800 uses 197, the 6502 uses only 151). However, some of the unused patterns will be executed by the control unit of the CPU; such "illegal" instructions may yield odd or even useful results.

There are three fundamental types of instructions: (1) those that simply *move* (actually, *copy*) a bit-pattern from one location into another; (2) those I shall refer to as "thinking operations" that *modify* or *analyze* bit-patterns; and (3) those that cause a *jump* or *branch* to an instruction other than the next one in sequence. Many types are so useful that *all* sets have them (e.g., MOVEs or logical ANDs between an on-chip register and any external memory location). Other types are omitted in some designs, or in all but one.

The strength of the Z-80 largely rests on its having the greatest variety of types, omitting relatively few of those present in other designs and adding many unique ones. No one will deny that the Z-80 set is more capable than that of the 8080, since it *includes* all of the 8080 instructions and *adds* to it many useful others. The inclusion of an older set, however, is not wholly positive since you retain not only its strengths but also its weaknesses. Also (as Adam Osborne has pointed out), the 8080 set uses 244 of the possible 256 one-byte op codes.

To enlarge the set, the Z-80 needs 382 two-byte and 62 three-byte op codes that load and run more slowly. This is one reason why the Z-80 *needs* a faster clock and high-speed memory. Four of the 12 bit-patterns not used in the 8080 set are used by the Z-80 as the first byte of its multibyte op codes, while the remaining eight are used as new one-byte op codes. *How* the Z-80 designers used this precious residue of fast codes is a valuable lesson in what *really* enhances a set, as we shall shortly see.

Strange as it may seem, an instruction type can be *too* powerful. The 8080 set has eight jump-on-condition instructions that allow the program to leap to *any* location in memory, but require a two-byte (absolute) address. Since these are among the most often-used instructions, such addressing increases both program bytes and execution time (especially in loops). Also, if a program is relocated in memory, every address has to be altered.

In the sets of the 6800 and 6502, there are only *relative* branch-on-condition instructions, whose op codes require only *one* address byte (interpreted as a signed binary number that is added to the program counter) but are limited to leaps in the range of +127 to -128 from the current program counter address. It is possible (though not efficient) for 6800/6502 programs to emulate the long 8080 conditional leaps by combining a conditional branch with their unconditional jump-absolute instruction, but in actuality this is almost never necessary.

> "The value of relative-branching is proved by the fact that Z-80 designers used six of their eight new one-byte op codes to create relative-branch instructions."

For example, the 2K ROM monitor of the MOS Technology KIM-1 has 752 instructions. Of these, 31 (4.1 percent of the total) are jump-absolutes, not one of which is conditional. The range limit of the 103 relative-branch instructions (13.7 percent of the total) is easily handled by careful program structuring (i.e., locating every block so that it lies within the range of the branchings to it).

If we compare the 687-byte 8080-Simulator Program by Lee Stork (September 1977 *Kilobaud*), we find that 14 (5 percent) of its 283 instructions are unconditional jumps and 39 (13.8 percent) are conditional ones. Of the latter, 26 are within a ± 127 range, and most (probably all) of the others could be brought within this range by program restructuring (although in an 8080 program there is no reason to do so).

The value of relative-branching is proved by the fact that Z-80 designers used six of their eight new one-byte op codes to create relative-branch instructions. One of these is unconditional, like the BRA (BRAnch) of the 6800 set, a fast short-range replacement for the 8080 JMP. It is interesting that the 6502 — with its vast supply of unused op codes — did not include a BRA. It can easily emulate it (at the cost of one more byte) by a "forced branch": clear a flag, then branch-if-flag-clear. Neither the 6502 nor the Z-80 adopted the 6800 BRS (unconditional relative-branch-to-subroutine). In fact, BRA and BRS can in no way eliminate their two-byte address equivalents (JMP and JSR), the essential long-leap instructions of the 6800/6502 sets.

Conditional jump (or branch) instructions occur frequently in programs because they are the decision/switching points. A *simple* condition, indicated by a single status flag bit, has two instructions: jump-if-flag-set (to 1) and jump-if-flag-reset (to 0). Two or more flag bits show a *complex* condition.

Many instructions alter more than one flag. For example, the COMPARE instruction, in effect, subtracts the content of some location X from the content of the accumulator A, but alters only the status register. If A < X, the carry flag is set by the 8080, Z-80 and 6800, while if A ⩾ X the carry is cleared (but in the 6502 the carry status is the exact *opposite*). If A = X, the zero flag is set. Only the 6800 has single instructions that (by testing two flags) branch if A > X (BHI) or A ⩽ X (BLS). The others need a sequence of two instructions.

For example, to jump to the address HAWAII if A ⩽ X, the 8080 needs a JC HAWAII followed by a JZ HAWAII, while the 6800 needs only a BLS HAWAII. The Signetics 2650 COMPARE does not involve the carry, but two condition-code

bits set to 00 if A = X, 01 if A > X, and 10 if A < X. It therefore needs two branch instructions to act on either A ⩾ X or A ⩽ X.

It is noteworthy that four of the six new Z-80 relative-branch instructions test the carry and zero flags, allowing it to react to the most important conditions much faster than the 8080. The other addition (DJNZ) decrements the B register and branches if it is not zero, allowing this register to efficiently control loops.

The 8080 set also includes eight conditional jump-to-subroutines and eight conditional returns. It is hard to tell how useful these are. All 16 CALLs in the Lee Stork program referred to above, and three of its four returns, are unconditional. Such instructions are not indispensable since the 6800/6502 get along well without them. However, the Signetics 2650 has six conditional subroutine calls (three absolute and three relative) and one conditional return.

All sets have the classic "thinking instructions": the logical AND, OR and exclusive OR that compare two bit-patterns on a bit-by-bit basis (always eight independent comparisons) and the arithmetic add, subtract and compare that treat the bit-pattern as a binary number. All have some rotate instructions that allow another kind of bit analysis and modification. The 6800 and 6502 also have arithmetic and logical shifts. The Z-80 includes *everything*, plus two tricky new ones (RRD and RLD).

I shall not attempt to explain the varied construction and use of these operations. I feel that all sets have enough power to do the most important and often-used things efficiently, and can, if necessary, emulate anything they lack by using a sequence of instructions.

One problem with all sets is that some instructions will rarely or never be used. For example, how often are the seven MOV R,R 8080 instructions (that move the content of one of the on-chip registers into the *same* register!) ever used in programs? This is one reason the mere *number* of instructions is not an ideal index of power.

The 6502 has one of the smallest sets, but even so, 37 (24%) of its 151 instruction op codes are not used in the KIM-1 ROM monitor. The percentage of non-utilization is likely to be much higher for the giant Z-80 set, especially since many of its new instructions are better than equivalent ones in its 8080 subset. However, the statistics of usage frequency (except for zero usage) are likely to be misleading.

Some instructions are essential, even though not often used, while others may be frequently used simply because more effective ones are not present in the set. Programmers learn to make do with whatever is available, and even tend to adopt a "mental subset" of instructions that they like — even when a task could be programmed as well or better by using less-favored instructions.

Experts can recognize programs written by amateurs, because they fail to use the full power of the set, and may even recognize a program written by a fellow-expert by its characteristic skillful exploitation of some instruction types. As with English writing, each tends to develop an individual style because every set is rich enough to allow one to "say" the same thing in a great variety of ways.

Not only do some instructions get neglected; others are (also for psychological reasons) not fully exploited, at least until one programmer breaks the ice. I recently discovered an example of such a "programmer mental block" involving the BIT instruction (absent in the 8080, present in different forms in the 6800, 6502 and Z-80). This is a logical AND between the primary accumulator (the on-chip register involved in the greatest number of instructions) and another location, which alters only the status register (whereas the conventional AND replaces the bit-pattern in the accumulator by the ANDed pattern).

Users of AND or BIT think of one of the two bit-patterns as a "mask" to clear or test bits in the other pattern. For example, if the bit-pattern being tested is X0X0X0X0, a mask of 01010101 will set the zero flag, thereby revealing that bits 0, 2, 4 and 6 were all zero.

> "The 6502 has one of the smallest sets, but even so, 37 (24 percent) of its 151 instruction op codes are not used in the KIM-1 ROM monitor."

The 6800 BIT has both immediate addressing (obviously to test an unknown bit-pattern in the accumulator by the mask of the program operand byte) and memory addressing (to test bits in a memory location by a mask previously loaded into the accumulator). In the 6502 set the BIT-immediate is omitted, creating the false impression that BIT can now only test bits in memory (although BIT logic neither knows nor cares where the "mask" is).

As far as I know, the first violation of this "test only bits in memory" rule — based on a mask concept existing only in the human mind — was in the 6502 Tracer program by Larry Fish (August 1977 *Kilobaud*), which used masks preset in memory locations to test bits in the accumulator. This is very useful, though not quite as fast or convenient as the 6800 BIT-immediate.

BIT is interesting as a specialized instruction that can easily be emulated by the conventional AND (although not exactly in its enhanced 6502 version, which also sets the overflow flag equal to bit 6 of the memory location), but will save some bytes and time in a program. The designers of the Signetics 2650 did not include BIT in its set. Instead, they added the unique TMI instruction, which also nondestructively compares the bit-pattern in an on-chip register with an immediate-operand bit-pattern.

If all the ones in the operand are also ones in the register, two "condition-code" bits in a status register are cleared. TMI is a kind of "reverse-BIT" that can test any "internal pattern" of ones, instead of "internal patterns" of zeros. It is harder to emulate with conventional logic, since the tested pattern must be complemented before being ANDed with the mask.

A set with both TMI and BIT would have no peer in its bit-analysis capability. This statement may come as a shock to admirers of the Z-80 who know that it has no less than 80 distinct BIT instructions in its arsenal! Although the Z-80 BIT has the same name, it is a less powerful instruction because it can test only single bits, not internal patterns of zero bits. The 6800/6502 BIT operates between two locations. Either one may contain a mask of any of the 256 possible eight-bit patterns. The Z-80 BIT operates on a single location without an explicit mask (the single-bit being tested is implied in the op code).■

Next time, we'll continue our examination of instruction sets.

✓Reader Service—see page 227

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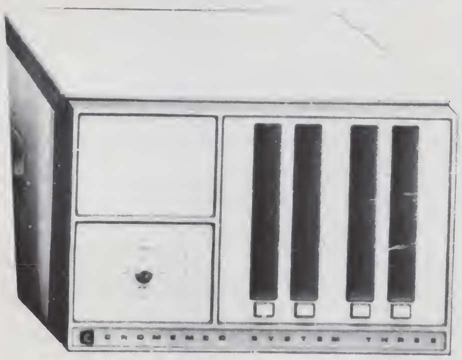

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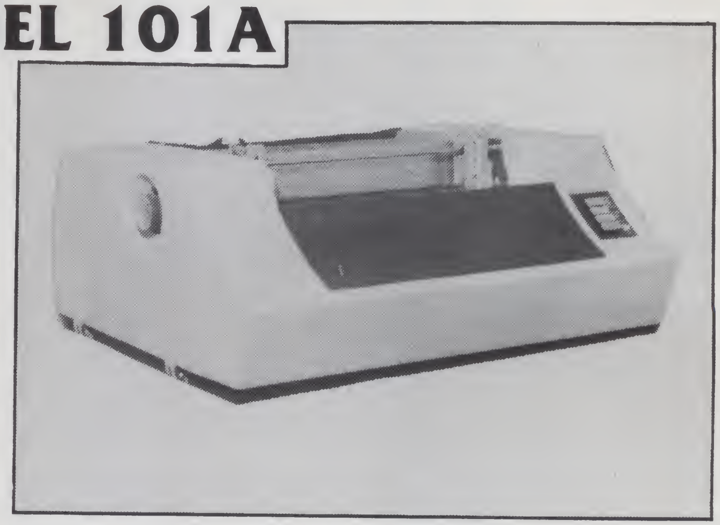

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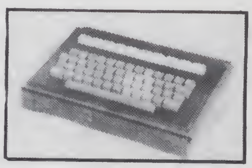

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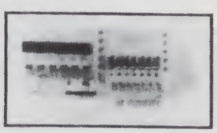

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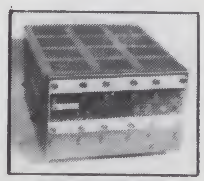

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5	20	30	35.00

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- Power Supply Components
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Start Computing For Just $129.95 With An 8085-Based Professional Computer Kit—

Explorer/85

100% compatible with all 8080A and 8085 software & development tools!

No matter what your future computing plans may be, Level "A"—at $129.95—is your starting point.

Starting at just $129.95 for a Level "A" operating system, you can now build the exact computer you want. Explorer/85 can be your beginner's system, OEM controller, or IBM-formatted 8" disk small business system...yet you're never forced to spend a penny for a component or feature you don't want and you can expand in small, affordable steps!

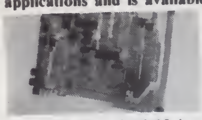
Now, for just $129.95, you can own the first level of a fully expandable computer with professional capabilities—a computer which features the advanced Intel 8085 cpu, *thereby giving you immediate access to all software and development tools that exist for both the 8085 and its 8080A predecessor (they are 100% software compatible)*—a computer which features onboard S-100 bus expansion—plus instant conversion to mass storage disk memory with either 5-1/4" diskettes or standard IBM-formatted 8" disks.

For just $129.95 (plus the cost of a power supply, keyboard/terminal and RF modulator, if you don't have them already), Explorer/85 lets you begin *computing* on a significant level... *applying* the principles discussed in leading computer magazines...*developing* "state of the art" computer solutions for both the industrial and leisure environment.

Level "A" Specifications

Explorer/85's Level "A" system features the advanced Intel 8085 cpu, an 8355 ROM with 2k deluxe monitor/operating system, and an 8155 ROM-I/O—all on a single motherboard with room for RAM/ROM/PROM/EPROM and S-100 expansion, *plus* generous prototyping space.

(Level "A" makes a perfect OEM controller for industrial applications and is available in a special Hex Version which can be programmed using the Netronics Hex Keypad/Display.)



Level "A" at $129.95 is a complete operating system, perfect for beginners, hobbiests, or industrial controller use.

PC Board: glass epoxy, plated through holes with solder mask • **I/O:** provisions for 25-pin (DB25) connector for terminal serial I/O, which can also support a paper tape reader ...provision for 24-pin DIP socket for hex keyboard/display...cassette tape recorder input...cassette tape recorder output...cassette tape control output...speaker output... LED output indicator on SOD (serial output) line...printer interface (less drivers)...total of four 8-bit plus one 6-bit I/O ports • **Crystal Frequency:** 6.144 MHz • **Control Switches:** reset and user (RST 7.5) interrupt...additional provisions for RST 5.5, 6.5 and TRAP interrupts onboard • **Counter/Timer:** programmable, 14-bit binary • **System RAM:** 256 bytes located at F800, ideal for smaller systems and for use as an isolated stack area in expanded systems...RAM expandable to 64k via S-100 bus or 4K on motherboard.

System Monitor (Terminal Version): 2k bytes of deluxe system monitor ROM located at F000 leaving 0000 free for user RAM/ROM. Features include tape load with labeling ...tape dump with labeling...examine/change contents of memory ...insert data...warm start...examine and change all registers...single step with register display at each break point, a debugging/training feature...go to execution address... move blocks of memory from one location to another...fill blocks of memory with a constant...display blocks of memory ...automatic baud rate selection...variable display line length control (1-255 characters/line)...channelized I/O monitor routine with 8-bit parallel output for high speed printer... serial console in and console out channel so that monitor can communicate with I/O ports.

System Monitor (Hex Version): Tape load with labeling... tape dump with labeling...examine/change contents of memory...insert data...warm start...examine and change all registers...single step with register display at each break point ...go to execution address. Level "A" in the *Hex Version* makes a perfect controller for industrial applications and can be programmed using the Netronics Hex Keypad/Display.

Hex Keypad/Display.

Hex Keypad/Display Specifications

Calculator type keypad with 24 system defined and 16 user defined keys. 6 digit calculator type display which displays full address plus data as well as register and status information.

Level "B" Specifications

Level"B" provides the S-100 signals plus buffers/drivers to support up to six S-100 bus boards and includes: address decoding for onboard 4k RAM expansion select-able in 4k blocks...address decoding for onboard 8k EPROM expansion selectable in 8k blocks...address and data bus drivers for onboard expansion...wait state generator (jumper selectable), to allow the use of slower memories...two separate 5 volt regulators.

Explorer/85 with Level "C" card cage.

Level "C" Specifications

Level "C" expands Explorer's motherboard with a card cage, allowing you to plug up to six S-100 cards directly into the motherboard. Both cage and cards are neatly contained inside Explorer's deluxe steel cabinet. Level "C" includes a sheet metal superstructure, a 5-card gold plated S-100 extension PC board which plugs into the motherboard. Just add required number of S-100 connectors

Level "D" Specifications

Level "D" provides 4k or RAM, power supply regulation, filtering decoupling components and sockets to expand your Explorer/85 memory to 4k (plus the original 256 bytes located in the 8155A). The static RAM can be located anywhere from 0000 to EFFF in 4k blocks.

Level "E" Specifications

Level "E" adds sockets for 8k of EPROM to use the popular Intel 2716 or the TI 2516. It includes all sockets, power supply regulator, heat sink, filtering and decoupling components. Sockets may also be used for soon to be available RAM IC's (allowing for up to 12k of onboard RAM).

Order A Coordinated Explorer/85 Applications Pak!

Experimenter's Pak (SAVE $12.50)—Buy Level "A" and Hex Keypad/Display for **$199.90** and get FREE Intel 8085 user's manual plus FREE postage & handling!

Student Pak (SAVE $24.45)—Buy Level "A," ASCII Keyboard/Computer Terminal, and Power Supply for **$319.85** and get FREE RF Modulator plus FREE Intel 8085 user's manual plus FREE postage & handling!

Engineering Pak (SAVE $41.00)—Buy Levels "A," "B," "C," "D," and "E" with Power Supply, ASCII Keyboard/Computer Terminal, and six S-100 Bus Connectors for **$514.75** and get 10 FREE computer grade cassette tapes plus FREE 8085 user's manual plus FREE postage & handling!

Business Pak (SAVE $89.95)—Buy Explorer/85 Levels "A," "B," and "C" (with cabinet), Power Supply, ASCII Keyboard/Computer Terminal (with cabinet), 16k RAM, 12" Video Monitor, North Star 5-1/4" Disk Drive (includes North Star BASIC) with power supply and cabinet, all for just **$1599.40** and get 10 FREE 5-1/4" minidiskettes ($49.95 value) plus FREE 8085 user's manual plus FREE postage & handling!

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Netronics R&D Ltd.,
333 Litchfield Road, New Milford, CT 06776

Please send the items checked below—

- ☐ **Explorer/85 Level "A" Kit** (ASCII Version), **$129.95** plus $3 p&h.
- ☐ **Explorer/85 Level "A" Kit** (Hex Version), **$129.95** plus $3 p&h.
- ☐ **8k Microsoft BASIC** on cassette tape, **$64.95** postpaid.
- ☐ **8k Microsoft BASIC in ROM Kit** (requires Levels "B," "D," and "E"), **$99.95** plus $2 p&h.
- ☐ **Level "B" (S-100) Kit, $49.95** plus $2 p&h.
- ☐ **Level "C" (S-100 6-card expander) Kit, $39.95** plus $2 p&h.
- ☐ **Level "D" (4k RAM) Kit, $69.95** plus $2 p&h.
- ☐ **Level "E" (EPROM/ROM) Kit, $5.95** plus 50¢ p&h.
- ☐ **Deluxe Steel Cabinet** for Explorer/85, **$49.95** plus $3 p&h.
- ☐ **ASCII Keyboard/Computer Terminal Kit** (features a full 128 character set, upper & lower case, full cursor control, 75 ohm video output convertible to baudot output, selectable baud rate, RS232-C or 20 ma. I/O, 32 or 64 character by 16 line formats, and can be used with either a CRT monitor or a TV set (if you have an RF modulator), **$149.95** plus $2.50 p&h.
- ☐ **Hex Keypad/Display Kit, $69.95** plus $2 p&h.
- ☐ **Deluxe Steel Cabinet** for ASCII Keyboard/Terminal, **$19.95** plus $2.50 p&h.
- ☐ **Power Supply Kit** (±8V @ 5 amps) in deluxe steel cabinet, **$39.95** plus $2 p&h.
- ☐ **Gold Plated S-100 Bus Connectors, $4.85** each, postpaid.
- ☐ **RF Modulator Kit** (allows you to use your TV set as a monitor), **$8.95** postpaid.
- ☐ **16k RAM Kit** (S-100 Board expands to 64k), **$199.95** plus $2 p&h.
- ☐ **32k RAM Kit, $329.95** plus $2 p&h.
- ☐ **48K RAM Kit, $459.95** plus $2 p&h.
- ☐ **64k RAM Kit, $589.95** plus $2 p&h.
- ☐ **16k RAM Expansion Kit** (to expand any of the above up to 64k), **$139.95** plus $2 p&h each.
- ☐ **Intel 8085 cpu User's Manual, $7.50** postpaid.
- ☐ **Special Computer Grade Cassette Tapes, $1.90** each or **3 for $5**, postpaid.
- ☐ **12" Video Monitor** (10 MHz bandwidth), **$139.95** plus $5 p&h.
- ☐ **North Star Double Density Floppy Disk Kit** (One Drive) for Explorer/85 (includes 3 drive S-100 controller, DOS, and extended BASIC with personalized disk operating system—just plug it in and you're up and running!), **$699.95** plus $5 p&h.
- ☐ **Power Supply Kit** for North Star Disk Drive, **$39.95** plus $2 p&h.
- ☐ **Deluxe Case** for North Star Disk Drive, **$39.95** plus $2 p&h.
- ☐ **Experimenter's Pak** (see above), **$199.90** postpaid.
- ☐ **Student Pak** (see above), **$319.85** postpaid.
- ☐ **Engineering Pak** (see above), **$514.75** postpaid.
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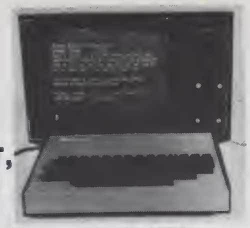
By Netronics

ASCII/BAUDOT, STAND ALONE



Computer Terminal

COMPLETE FOR ONLY... $149.95

The Netronics ASCII/BAUDOT Computer Terminal Kit is a microprocessor-controlled, stand alone keyboard/terminal requring no computer memory or software. It allows the use of either a 64 or 32 character by 16 line professional display format with selectable baud rate, RS232-C or 20 ma. output, full cursor control and 75 ohm composite video output.

The keyboard follows the standard typewriter configuration and generates the entire 128 character ASCII upper/lower case set with 96 printable characters. Features include onboard regulators, selectable parity, shift lock key, alpha lock jumper, a drive capability of one TTY load, and the ability to mate directly with almost any computer, including the new Explorer/85 and ELF products by Netronics.

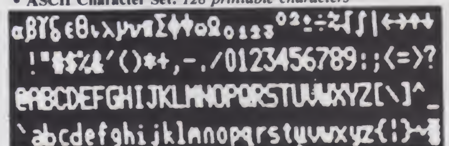
The Computer Terminal requires no I/O mapping and includes 1k of memory, character generator, 2 key rollover, processor controlled cursor control, parallel ASCII/BAUDOT to serial conversion and serial to video processing—fully crystal controlled for superb accuracy. PC boards are the highest quality glass epoxy for the ultimate in reliability and long life.

VIDEO DISPLAY SPECIFICATIONS

The heart of the Netronics Computer Terminal is the microprocessor-controlled Netronics Video Display Board (VID) which allows the terminal to utilize either a parallel ASCII or BAUDOT signal source. The VID converts the parallel data to serial data which is then formatted to either RS232-C or 20 ma. current loop output, which can be connected to the serial I/O on your computer or other interface, i.e., Modem.

When connected to a computer, the computer must echo the character received. This data is received by the VID which processes the information, converting to data to video suitable to be displayed on a TV set (using an RF modulator) or on a video monitor. The VID generates the cursor, horizontal and vertical sync pulses and performs the housekeeping relative to which character and where it is to be displayed on the screen.

Video Output: *1.5 P/P into 75 ohm (EIA RS-170)* • **Baud Rate:** *110 and 300 ASCII* • **Outputs:** *RS232-C or 20 ma. current loop* • **ASCII Character Set:** *128 printable characters—*



BAUDOT Character Set: *A B C D E F G H I J K L M N O P Q R S T U V W X Y Z - ? : • 3 $ # ( ) . , 9 0 1 4 ! 5 7 ; 2 / 6 8 •* **Cursor Modes:** *Home, Backspace, Horizontal Tab, Line Feed, Vertical Tab, Carriage Return. Two special cursor sequences are provided for absolute and relative X-Y cursor addressing* • **Cursor Control:** *Erase, End of Line, Erase of Screen, Form Feed, Delete* • **Monitor Operation:** *50 or 60Hz (jumper selectable.*

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Netronics R&D Ltd., Dept. K3
333 Litchfield Road, New Milford, CT 06776

Please send the items checked below—

- ☐ **Netronics Stand Alone ASCII Keyboard/Computer Terminal Kit, $149.95** plus $3.00 postage & handling.
- ☐ **Deluxe Steel Cabinet** for Netronics Keyboard/Terminal In Blue/Black Finish, **$19.95** plus $2.50 postage and handling.
- ☐ **Video Display Board Kit** alone (less keyboard), **$89.95** plus $3 postage & handling.
- ☐ **12" Video Monitor** (10 MHz bandwidth) fully assembled and tested, **$139.95** plus $5 postage and handling.
- ☐ **RF Modulator Kit** (to use your TV set for a monitor), **$8.95** postpaid.
- ☐ **5 amp Power Supply Kit** In Deluxe Steel Cabinet (±8VDC @ 5 amps, plus 6-8 VAC), **$39.95** plus $2 postage & handling.

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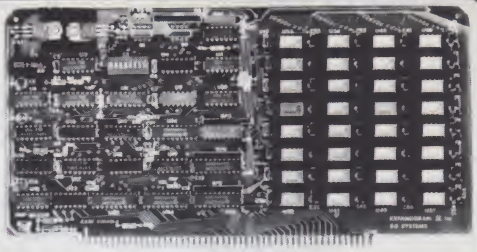
4 MHZ EXPANDORAM II KIT

The S-100 Memory Board for the 80's

NEW



SD SYSTEMS' ExpandoRAM II is a state-of-the-art dynamic RAM board with capacities from 16K bytes (4116) to 256K bytes (4164). It operates on the industry S-100 Bus. The ExpandoRAM II's design allows eight boards to operate from the same S-100 Bus. Page mode operation provides the system with the capability of servicing multiple users without RAM interference. Invisible refresh and synchronization with wait states provide greater reliability, and processing speeds up to 4 Mhz.

The ExpandoRAM II is compatible with most S-100 CPU's based on the Z80 microprocessor. When other SD SYSTEMS 200 series boards are combined with the ExpandoRAM II, they create a microcomputer with exceptional capabilities and features.

- S-100 Bus Compatible
- Up to 4Mhz Operation
- Expandable Memory from 16K to 256K
- DIP Switch Selectable Boundaries
- Uses 16K (4115) or 64K (4164) Memory Devices
- Page Mode Operation Allows up to 8 Memory Boards on Bus
- Operates with Z80 CPU's
- Phantom Output Disable
- Invisible Refresh (Synchronized with Wait States)

SDS - EXPANDOPRAM II KIT (4116)

	List Price	Sale Price		List Price	Sale Price
16K	$460.00	$295.00	48K	$960.00	$445.00
32K	$710.00	$370.00	64K	$1210.00	$520.00

VCT-8803 Vector

MOTHER BOARD FOR S100 BUS MICRO-COMPUTERS

- Kit includes 12 tantalum capacitors for +5, +12, —12 buses and insulated mounting spacers
- Wiring side shown. Component side bare epoxy glass with white markings for component locations
- G10 epoxy glass board with 2 ounce copper, solder plated and .038 diameter holes for leads
- Solder mask with solder windows on etched circuits to avoid accidental short circuits
- Mounts 11 receptacles with 100 contacts (2 rows) on .125 centers with .250 row spacing. Vector part number R681-2, or mounts 10 receptacles plus interconnections to smaller mother board for expansion
- Includes etched circuits and instructions for option of active, pull-up, or floating terminations
- Large buses +5V and GND (10 AMPS), ± 12V or 16V (7 AMPS). Current ratings are per MIL-STD-275 with 10°C rise
- Fits in Vector-pak enclosures
- Fits in IMSAI 8080 microcomputer as expander board

Price: $29.50

VCT8800V

Universal Microcomputer/processor plugboard, use with S-100 bus. Complete with heat sink & hardware, 5.3" x 10" x 1/16"

1-4	5-9	10-24
$19.95	$17.95	$15.96

VCT8801-1

Same as 8800V except plain, less power buses & heat sink.

1-4	5-9	10-24
$15.22	$13.79	$12.18

Vector Plugboards

VCT3682 9.6"x4.5" $12.97
VCT3682-2 6.5"x4.5" $9.81
Hi-Density Dual-In-Line Plugboard for Wire Wrap with Power & Grd. Bus Epoxy Glass 1/16" 44 pin. con. spaced .156

VCT3677 9.6"x4.5" $10.90
VCT3677-2 6.5"x4.5" $9.74
Gen. Purpose D.I.P. Boards with Bus Pattern for Solder or Wire Wrap. Epoxy Glass 1/16" 44 pin con. spaced .156

VCT3662 6.5"x4.5" $8.95
VCT3662-2 9.6"x4.5" $11.45
P pattern plugboards for IC's Epoxy Glass 1/16" 44 pin con. spaced .156.

VCT3690-12 CARD EXTENDER
Card Extender has 100 contacts 50 per side on .125 centers-Attached connector is compatible with S-100 Bus Systems............$25.83
VCT3690 6.5"22/44 pin... .156 ctrs.Extenders..$13.17

S-100 BUS EDGE CONNECTORS*

SALE SALE

CG 1 (MSA) Style Card Guides 5/$1.00

Texas Instruments GOLD S-100 CONNECTORS

TI-S100-STG SOLDER TAIL 5/$10.00 or TI-S100-WWG WIRE WRAP 3/$10.00

S100SEG 50/100 Cont .125 ctrs. PIERCED SOLDER EYELET Tails GOLD

1-9	10-24	25-99
$6.80	$6.10	$5.45

SUL-S100ALT 50/100 Cont .125 ctrs. DIP SOLDER TAIL on 140 spaced rows for ALTAIR motherboards, GOLD plated.

1-9	10-24	25-99
$4.95	$4.45	$3.95

Other Popular Edge Connectors

SUL-D2244-5WWG 22/44 Cont .156 ctrs.WIRE WRAP tails GOLD.

1-9	10-24	25-99
$3.98	$3.50	$3.00

SUL-D2244-5SEG 22/44 Cont .156 Ctrs.PIERCED SOLDER EYELET tails GOLD plated.

1-9	10-24	25-99
$2.98	$2.90	$2.75

RS232 and "D" SUB-MINIATURE CONNECTORS*

P = Plug, Male Type - S = Socket, Female Type - C = Cover, Hood

PART NO.	DESCRIPTION	PRICE 1-9	10-24	25-99
CND-DE9P	9 Pin Male	1.60	1.40	1.30
CND-DE9S	9 Pin Female	2.25	2.00	1.90
CND-DE9C	9 Pin Cover	1.50	1.35	1.20
CND-DA15P	15 Pin Male	2.35	2.15	2.00
CND-DA15S	15 Pin Female	3.25	3.10	2.90
CND-DA15C	15 Pin Cover	1.60	1.45	1.30
CND-DB25P	25 Pin Male	2.80	2.60	2.40
CND-DB25S	25 Pin Female	3.60	3.40	3.20
CND-DB51212-1	1 pc.Grey Hood	1.50	1.30	1.10
CND-DB110963-3	2 pc.Grey Hood	1.75	1.50	1.35
CND-DB1226-1A	2 pc.Black Hood	1.90	1.65	1.45
CND-DC37P	37 Pin Male	4.20	4.00	3.70
CND-DC37S	37 Pin Female	6.00	5.75	5.50
CND-DC37C	37 Pin Cover	2.25	2.00	1.75
CND-DD50P	50 Pin Male	5.50	5.10	4.75
CND-DD50S	50 Pin Female	9.40	8.60	8.00
CND-DD50C	50 Pin Cover	2.40	2.20	2.00
D20418-S	Hardware Set 2 pr.	1.00	.80	.70
CND-RS232-8FT	RS232, DB25P, EIA class 1 cable 8 con. 6 ft. long	18.00	16.00	14.00
CND-57-30360	Centronics 700 Series printer connector	9.00	7.50	6.00

MALE FEMALE

1/16 Vector BOARD .042 dia holes on 0.1 spacing for IC's

PART NO.	SIZE	PRICE 1-9	10-19
Phenolic			
VCT64P44XXXP	4.5x6.5"	$1.56	$1.40
VCT169P44XXXP	4.5x17"	$3.69	$3.32
Epoxy Glass			
VCT64P44	4.5x6.5"	$1.79	$1.61
VCT84P44	4.5x8.5"	$2.21	$1.99
VCT169P44	4.5x17"	$4.52	$4.07
VCT169P84	8.5x17"	$8.83	$7.95

3 LEVEL GOLD WIRE WRAP SOCKETS PRICE*

PART NO.	PINS	1-9	10-24	25-99	100-249	250-999
RNS-08WWG	8	.40	.36	.34	.31	.27
RNS-14WWG	14	.50	.39	.37	.35	.32
RNS-16WWG	16	.55	.42	.40	.37	.34
RNS-18WWG	18	.75	.65	.60	.55	.50
RNS-20WWG	20	.90	.80	.70	.65	.62
RNS-22WWG	22	1.00	.90	.85	.80	.75
RNS-24WWG	24	1.00	.90	.85	.80	.75
RNS-28WWG	28	1.40	1.30	1.25	1.10	1.00
RNS-40WWG	40	1.65	1.45	1.35	1.25	1.20

*Price based on gold not exceeding $400.00 per oz.

3M SCOTCH® BRAND DISKETTES

Part No.	Sides/ Density	Sectoring	Price Box of 10
		8"	
740-OK	1/single	Soft-IBM	$39 95
740/2-OK	2/single	Soft-IBM	$75 00
740-32K	1/single	32	$39 95
740/2-32K	2/single	32	$75 00
741-0	1/double	Soft	$59.00
		5"	
744-OK	1/single	Soft-(TRS-80)	$39 95*
744-10K	1/single	Soft/10	$39 95*
744-16K	1/single	Soft/16	$39 95*

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ROCKWELL AIM-65

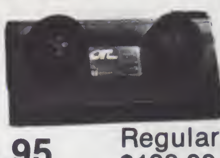
The Rockwell AIM 65 with 4K
RCK-AIM65-4K 8 lbs..................$445.00

The Rockwell AIM 65 with 1K
RCK-AIM65 1K 8 lbs..................$395.00

4K Assembled--RCK-AIM65-010..........$ 85.00

8K Basic in ROM--RCK-AIM65-020.......$100.00

NOVATION CAT ACOUSTIC MODEM



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- Bell 103
- Answer, Originate

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8 for $65.00
Add $3.00 for programming Jumpers for TRS-80 Keyboard

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2114-3L	1Kx4 300ns Low Power	8/$50.00
5257-3L	4Kx1 300ns Low Power	8/$55.00
2708	8K 450ns EPROM	8/$60.00 - $8.50 ea
2716	16K 5 Volt only EPROM	8/$240-$32.00 ea

Vector WRAP POST

for .042 dia. holes (all boards on this page)
T44/C pkg. 100 .. $ 2.34
T44/M pkg. 1000 ..... $14.35
A-13 hand installing tool .... $ 4.19

P21

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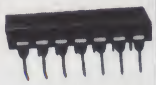

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74LS47	276-1916	1.29
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74LS93	276-1925	.99
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4511	276-2447	1.69
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4050	276-2450	.79
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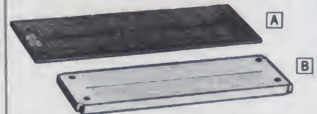

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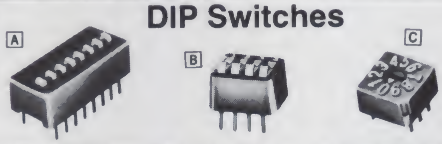

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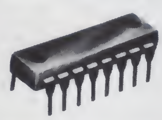

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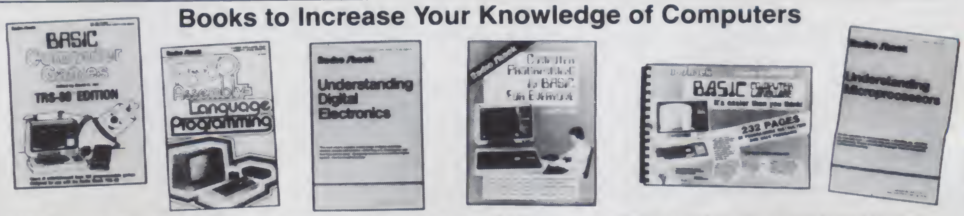

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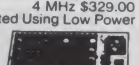

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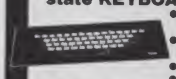

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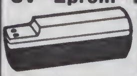

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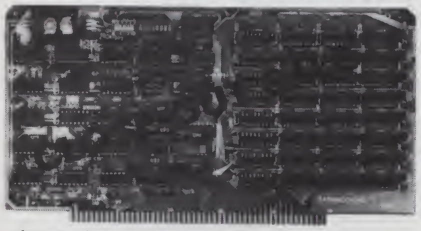

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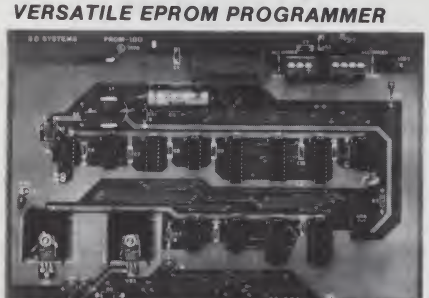

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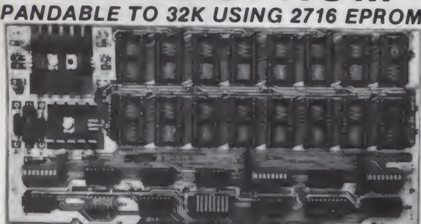

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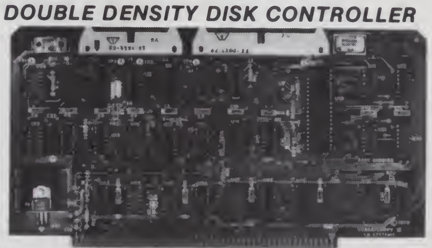

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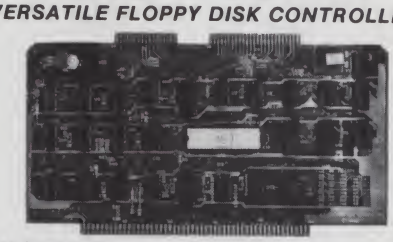

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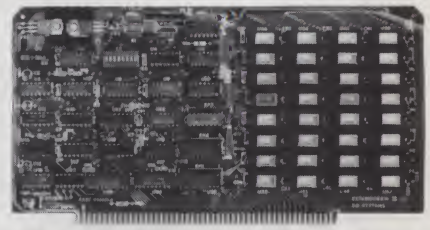

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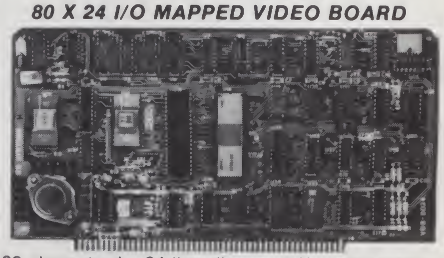

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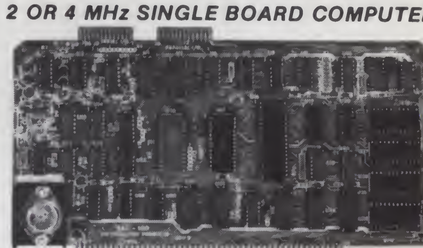

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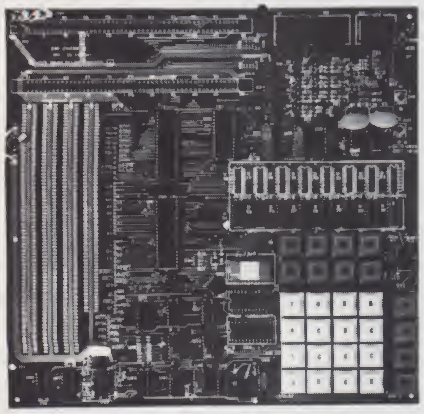

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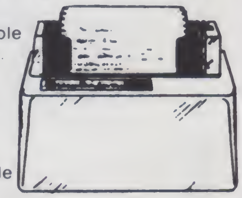

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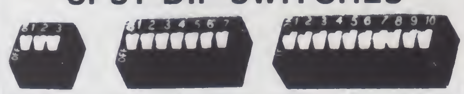

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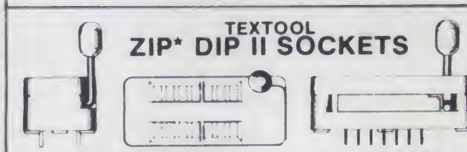
SWD-103	3	$1.00	~~$1.18~~
SWD-104	4	$1.05	~~$1.20~~
SWD-105	5	$1.10	~~$1.24~~
SWD-106	6	$1.15	~~$1.26~~
SWD-107	7	$1.20	~~$1.30~~
SWD-108	8	$1.25	~~$1.34~~
SWD-109	9	$1.30	~~$1.36~~
SWD-110	10	$1.35	~~$1.38~~

TEXTOOL
ZIP* DIP II SOCKETS

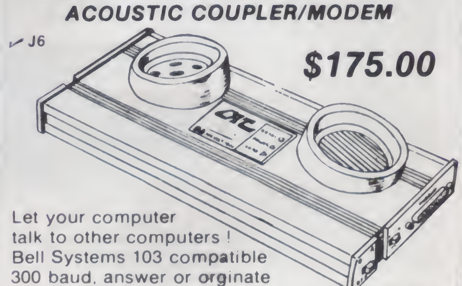


16 PIN ZIP* DIP II **$5.50**
24 PIN ZIP* DIP II **$7.50**
40 PIN ZIP* DIP II **10.25**
* ZERO INSERTION PRESSURE

SPECIAL FEBRUARY PRICE !
NOVATION CAT
ACOUSTIC COUPLER/MODEM

J6

$175.00



Let your computer talk to other computers !
Bell Systems 103 compatible
300 baud, answer or orginate
IOM-5200A (SALE PRICED) **$175.00**

10-DAY FREE TRIAL

Send for our FREE Catalog

$100 FREE ACCESSORIES WITH 16K or 32K PET

When you buy a 16K or 32K PET, apply $100 toward PET accessories, FREE! Just indicate on your order that you have reduced the cost of your accessories by $100.

FREE Terminal Package with 8K PETs
See Special Below

SAVE $98

8K-Keyboard N	**$795**
16K-Keyboard B	**$995**
16K-Keyboard N	**$995**
32K-Keyboard B	**$1,295**
32K-Keyboard N	**$1,295**

B — large keyboard (graphics not on keys)
N — large keyboard with graphics symbols

PET ACCESSORIES

Commodore Dual Floppy Disk Drive	$1,295.00
Commodore Printer (friction feed)	$849.00
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Commodore PET Service Kit	$30.00
Beeper-Tells when tape is loaded	$24.95
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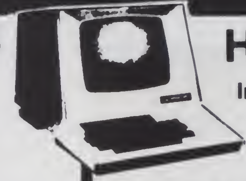
Video Buffer-Attach another CRT	$29.95
Combo-Petunia and Video Buffer	$49.95
TNW Bi-Dir. RS-232 printer X-face	$229
KIM 1 (A Single Board Computer from Commodore)	$179.00



Hazeltine

Immediate Delivery —

SUPER SALE!

1410 $749 REG $900
1500 $995 REG $1069

Hazeltine 1510 — $1195 **Hazeltine 1520 — $1499**

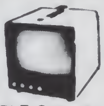
Lear Siegler's ADM-3A

The ADM-3A is industry's favorite dumb terminal for some very smart reasons:

- 12 in. diagonal screen
- Full or half duplex operation at 11 selectable data rates
- 1920 easy-to-read characters in 24 rows of 80 letters
- Typewriter-style keyboard
- RS-232 C interface extension port
- Direct cursor addressing

Our Low Sale Price $795

SANYO MONITORS



9-inch **SALE! $169**
15-inch **SALE! $279**

Perfect for PET & APPLE Owners...
Sanyo cassette recorder $55

REMOTE TERMINAL

for only $98

A self-contained module and program cassette enables your PET to function as a 300 baud terminal. Supports Upper/Lower case, Rubout, Escape and all control functions. Output is TTL. Can be used with THE SOURCE. You will need the Terminal Option, Cat Coupler & EIA Cable to do this. Complete package which includes all 3 avail. from CompuMart for **$279.**

FREE WITH PET PURCHASE

CAT COUPLER

New 300 baud Originate/Answer Acoustic Coupler Looks good, works great

SALE $179

NEW! ZENITH COLOR VIDEO MONITOR

Zenith's first color video display designed specifically for computers.

This 13-inch monitor is Zenith's first color video display designed specifically for computers. Features include automatic color level, color processing and degaussing circuits.

Zenith Color Monitor $499.00

apple II plus

$200 FREE ACCESSORIES

The new Apple II with Applesoft BASIC built-in! Eliminates the need for a $200 Firmware Card and includes new Autostart ROM for easy operation. This combined with the FREE accessories from NCE could save you up to $400 on a 48K Apple II system!

16K Apple II Plus — $1195 (take $100 in free accessories)
32K Apple II Plus — $1345 (take $150 in free accessories)
48K Apple II Plus — $1495 (take $200 in free accessories)

Apple II Accessories

General Business	$625
PASCAL	$495
Integer BASIC ROM Card	$200
VISI-Calc	$99
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Parallel Printer Card	$180
Communications Card	$225
Hi-Speed Serial Card	$195
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EVERY ITEM IN THIS ADVERTISEMENT IS IN STOCK AND READY TO SHIP, EXCEPT WHERE NOTED.

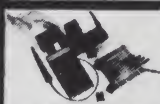
Excellent Performance—Looks Great

The TNW-2000

Bi-Directional RS-232 Serial Interface

Interface your PET to printers, modems, CRT terminals, plotters, paper tape readers and punches — or other computers. The TNW-2000 Serial Interface lets you connect your PET to RS-232 serial devices. Comes assembled and tested with cable to connect unit to an IEEE Standard or Commodore PET connector.

TNW Bi.-Dir. RS-232 printer X-face $229



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A Calculator, A System, A Whole New Standard.

HEWLETT-PACKARD'S HP-41C.

130 built-in functions • Alpha capability • 400 lines expandable up to 2,000 of program memory • Continuous memory • RPN logic.

"Customize it. Reassign any program or standard function to any keyboard location you want.

Enhanced programmability. Up to 6 levels of subroutines; 10 conditionals, 56 internal flags, specific loop control, indirect addressing, local & global branching HP-41C Calc. $288

THE SYSTEM.

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"Extra smart" Card Reader. $180 Records programs & data onto blank mag-cards.

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CONTINUOUS MEMORY CALCULATORS
HP-33C-$114.95, HP-34C-$144.95, HP-38C-$144.95

PAPER TIGER 440SPE

The Graphics Printer for Apple II

Now you can print illustrations, block letters, charts, graphs, and more — all under software control. And with the expanded buffer, the Paper Tiger can hold the text from an entire 24-line-by-80-column CRT screen.

$1194.00

HEATH

The All-In-One Computer

Dual Z-80 Processors • Built-in 102K Floppy Disk • 16K to 48K RAM • 25 x 80 Character Display • Upper/Lower Case and Line Graphics • 80 Character Keyboard with Keypad • 8 User-definable Keys • Two BASIC's and Auto-Scribe Word Processing available • Can support CP/M

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WH89 with 32K RAM	$2,445
WH89 with 48K RAM	$2,595
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Dual-port Serial Interface	$85
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Phones open from 8:30 a.m. to 5:30 p.m. EST Mon.-Fri. • P.O.'s accepted from D&B rated companies — shipment contingent upon receipt of signed purchase order • Sorry no C.O.D.s • All prices are subject to change without notice • Most items in stock for immediate shipment — call for delivery quotation • In the Ann Arbor area? Our retail store is open 11:00 a.m. to 7:00 p.m. Tues.-Fri., 10:00 a.m. to 5:00 pm. Saturdays (closed Sun. and Mon.)

If not satisfied, return your purchase with-in 10 days for full refund of purchase price!

Power Supplies! Power Supplies! Power Supplies! SOLID STATE!! (5)

We got 'em! Take your pick...

These units are ideal for micro computers. They have been removed from equipment, checked out and guaranteed.

1—5 volts @ 8 amps + 12 volts @ 2 amps + 6 volts @ 75 MA. Power supply has a 3-wire line cord and fused. Dimensions: 10½" × 5½" × 4½". Shipping weight: 16 lbs. . . . . . 37.50 ea. 2/70.00

2—Model 818, 5 volts at 15 amps + 12 volts at 4 amps–12 volts at 2 amps. (with line cord). . . . . . 35.00 ea. 2/65.00

3— + 5 volts at 5 amps ± 12 volts at 500 ma. + 6 volts at 25 ma. (line cord included). . . . . . 32.95 ea. 2/60.00

4---Elexon, multi output. Input: 120/240 AC, ±10%, 47-63 hz; output: 1) 12V, 1.5A, DC, OVP; 2) 12V, 1.5A, D.C., OVP. New, in box with operating instructions. 31.50

5---Power Design, Model 1210, constant voltage, DC. P.S. input: 105-125. A.C., 55 to 440 hz. Output: 1-12 volts, 0-10 amps, DC. continuously adjustable output voltage and current limiting. 139.00

COMPUTER GRADE CAPACITORS . . .

18,000 mfd 10 VDC	1.25	11,000 mfd 25 VDC	1.50	4,000 mfd 75 VDC	1.75
4,400 mfd 20 VDC	1.00	35,000 mfd 35 VDC	3.50	1,000 mfd 100 VDC	1.00
46,000 mfd 20 VDC	2.50	10,000 mfd 50 VDC	2.50	6,800 mfd 100 VDC	3.50
3,000 mfd 25 VDC	1.00	22,000 mfd 60 VDC	3.75	4,700 mfd 150 VDC	3.75

WIRE WRAP BOARDS

These boards have been removed from equipment. They're prewired, and very easy to unwrap for setting up your own boards. Contains mostly 14-pin IC sockets with individual connections. Each board has VCC and ground planes.

Smaller board measures 6½"x6" and has 40 to 50 sockets. Reduced Price . . . $7.50 ea. 2/$14.00

Larger board measures 13½"x6" and has 75 to 100 sockets. Reduced Price . . . $12.50 ea. 2/$23.00

DIABLO System Disc Drive

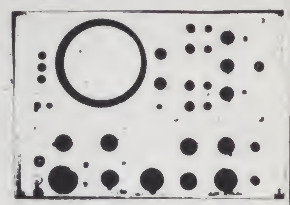
SERIES 40, MODEL 43

100 tracks per inch, total capacity of 50 megabits, w/Model 429 power supply, sector counter, 24 sectors, 1 fixed disc, 1 removable disc, average access time 38 ms, PPM:2400, dimensions: 10 5/16" high, fits in standard rack, equipped with full extension slides, excellent used condition. Shipped freight collect.

$2495

HEWLETT-PACKARD MODEL 175A OSCILLOSCOPES

THESE SCOPES HAVE A 50 MHZ BANDWIDTH AND HAVE 2 PLUG-INS, A 1781B DELAY GENERATOR AND A MODEL 1755A DUAL TRACE VERTICAL AMPLIFIER. DIMENSIONS: 13" × 17" × 25", WEIGHT 71 LBS, SHIPPED FREIGHT COLLECT. 5" CRT. USED. CHECKED OUT AND OPERATING.



$339

TRANSFORMERS

ISOLATION STEP-DOWN TYPE

Primary: 230/115V, 50/60 CPS, Secondary: 115 volts output 250 VA.

$13.95 EACH

ROTRON WHISPER FANS

Unused, Model Rotron MU 3A1, 230V, AC, 14 watts, 50/60 hz, guaranteed, 4½"x4½"x1½"

$8.95

Clock Crystal Oscillators--TTL, Vectron, type CO-231T. Crystal freq. 4.9152 mhz. Input voltage 5 VDC ±. Output: Drives 10 TTL Loads Logic "0": 0.4V max., sink 16ma. Logic "1" 2.4V min source 2 ma. (above 50 mhz drives 2 Schottky TTL loads). Tuning adjust. with nominal range of ±30 ppm below 25 mhz and 15 ppm above 25 mhz. R.F.E. 1½"x1½"x½". $13.95

SG-132 SWEEP SIGNAL GENERATOR

FREQ: 15 TO 400 MHZ, VHF-UHF

Output: AM & FM: CW. FM deviation: ± 1% to ± 20% at any frequency. Crystal markers every 200Khz, 1mhz, 5mhz or ± 10B. Frequency accuracy ±1%. Built-in oscilloscope for observing waveforms.

$329

TRENDLINE PHONES

Manufactured by I.T.T.

These units have rotary dials. Colors are: white, black, red, and green. They are packaged and have 6-foot cord and installation instrructions. Used, but in good operating condition.

34.50 WALL TYPE

Minimum order $25.00. Items offered subject to prior sale. FOB, Brockton, Mass. Money order or check w/order. Shipments and handling add 5%. Shipments by parcel post or UPS. No CODs. Mass. residents add 5% sales tax.

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Whether it's memory, motherboards, I/O boards, enclosures, or any of our family of products, **CompuPro™** delivers what you want at prices you can afford.

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Memory name	Buss & Notes	Unkit	Assm	CSC
8K Econoram* IIA	S-100	**$149**	**$179**	**$239**
16K Econoram IV	S-100	**$289**	**$339**	**$429**
16K Econoram VIIA-16	S-100	**$299**	**$349**	**$439**
24K Econoram VIIA-24	S-100	**$419**	**$499**	**$605**
16K Econoram IX-16	Dig Grp	**$319**	**$379**	n/a
32K Econoram IX-32	Dig Grp	**$559**	**$639**	n/a
32K Econoram X	S-100	**$549**	**$669**	**$789**
32K Econoram XI	SBC/BLC	n/a	n/a	**$1050**
16K Econoram XIIIA-16	S-100 (1)	**$349**	**$419**	**$519**
24K Econoram XIIIA-24	S-100 (1)	**$469**	**$539**	**$649**
32K Econoram XIIIA-32	S-100 (1)	**$579**	**$699**	**$849**
16K Econoram XIV	S-100 (2)	**$299**	**$359**	**$459**
16K Econoram XV-16	H8 (3)	**$329**	**$395**	n/a
32K Econoram XV-32	H8 (3)	**$599**	**$729**	n/a

***Econoram** is a trademark of **Godbout Electronics**

(1) Compatible with all bank select systems (Cromemco, Alpha Micro, etc.); addressable on 4K boundaries.

(2) Extended addressing (24 address lines). Single block addressable on 4K boundaries.

(3) Bank select option for implementing memory systems greater than 64K.

16K DYNAMIC RAMS 8/$87.20!

Perfect for memory expansion in a number of machines (**TRS-80**** Model I and Model II, **Exidy Sorcerer**, **Heath H89**, **Apple**, etc.), and you can't beat our price: 8 high speed chips for $64! Add $3 if you'd like 2 dip shunts plus TRS-80** programming instructions to expand memory. These are 250 ns (4 MHz), dynamic RAMs... but quantities are limited, so hurry is you want to take advantage of this super deal.

**TRS-80 is a trademark of the Tandy Corporation.

PASCAL/M™ + MEMORY SPECIAL

PASCAL can give a microcomputer with CP/M more power than many minis. For a limited time only, you can buy an assembled Econoram X, plus our totally standard Wirth PASCAL/M™ 8" diskette, for $799 (regular combined price, $999). Includes manual, plus Wirth's definitive book on PASCAL; specify Z-80 or 8080/8085 version. Diskette is also available separately for $350.

2708 EROM BOARD $85 unkit

4 independently addressable 4K blocks, with dip-switch selectable jump start built right into the board. Includes all support chips and manual, but does not include EROMs.

THESE PRODUCTS ARE GENERALLY AVAILABLE FROM YOUR LOCAL COMPUTER STORE.

S-100 MEMORY MANAGER BOARD

$59 unkit
$85 assm
$100 CSC

Add bank select and extended addressing to older S-100 machines (Altair, IMSAI, Sol, and others). Use with our new extended addressing boards, or retrofit our high density **Econorams** for use with the **Memory Manager** to get added memory space for your computer.

ACTIVE TERMINATOR BOARD **$34.50 kit**

Plugs into any S-100 motherboard (although ours don't need it) to reduce ringing, crosstalk, noise, and other buss-related problems.

MULLEN S-100 EXTENDER BOARD $49 kit

Includes logic probe and general purpose breadboard section. Ideal for troubleshooting and analysis.

THE GODBOUT COMPUTER BOX

$259 desktop, $299 rack mount (introductory price)

The ideal home for your computer. With fan, dual AC outlets and fuseholder, power switch, heavy-duty line filter, black anodized front panel (with textured vinyl painted cover for desk top version); pre-drilled base accepts our high-performance motherboards or similar types by Vector, California Digital, and others. Rack mount version includes slides for easy pull-out from rack. This functional, versatile, and handsome enclosure does justice to the finest computer systems.

3P PLUS S "Interfacer II" S-100 I/O BOARD

$199 unkit
$249 assm
$324 CSC

Incorporates 1 channel of serial I/O (RS-232 with full handshake), along with 3 full duplex parallel ports plus a separate status port. The parallel section uses Tri-State (tm National Semiconductor) octal latches for latched data, input and output with 24 mA drive current, attention/enable/strobe bits for each parallel port (with selectable polarity), interrupts for each input port, and separate connectors with power for each channel.

HIGH-PERFORMANCE S-100 MOTHERBOARDS

6 slot: **$ 89** unkit, **$129** assm **12 slot:** **$129** unkit, **$169** assm
19 slot: **$174** unkit, **$214** assm

Unkits have edge connectors and termination resistors pre-soldered in place for easy assembly. These boards exceed the latest S-100 specs and will work with 5 to 10 MHz CPUs. Includes true active termination, grounded Farady shield between all buss signal lines, and edge connectors for all slots.

2S "Interfacer I" S-100 I/O BOARD

$199 unkit
$249 assm
$324 CSC

Dual RS-232 ports with full handshake; use EIA232C line drivers and receivers (1488, 1489), or current loop (20 mA), or TTL signals on both ports. On-board crystal timebase with independently selectable Baud rates for each port (up to 19.2 KBaud). Hardware UARTs don't tie up the CPU.

CompuPro™ from GODBOUT ELECTRONICS ✓G41
Bldg. 725, Oakland Airport, CA 94614

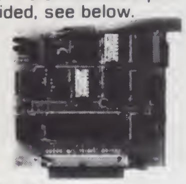
TERMS: Cal res add tax. Allow 5% for shipping, excess refunded. VISA*/Mastercharge* call our 24 hour order desk at **(415) 562-0636**. COD OK with street address for UPS. Prices good through cover month of magazine.

✓ Reader Service—see page 227

E21

TRS-80 E.S. SERIAL I/O

• Can input into basic • Can use LLIST and LPRINT to output, or output continuously • RS-232 compatible • Can be used with or without the expansion bus • On board switch selectable baud rates of 110, 150, 300, 600, 1200, 2400, parity or no parity odd or even, 5 to 8 data bits, and 1 or 2 stop bits. D.T.R. line • Requires +5, -12 VDC • Board only $19.95 Part No. 8010, with parts $59.95 Part No. 8010A, assembled $79.95 Part No. 8010 C. No connectors provided, see below.



EIA/RS-232 connector Part No. DB25P $6.00, with 9', 8 conductor cable $10.95 Part No. DB25P9.

3' ribbon cable with attached connectors to fit TRS-80 and our serial board $19.95 Part No. 3CAB40.

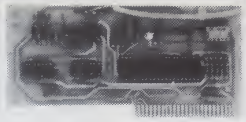
MODEM

• Type 103 • Full or half duplex • Works up to 300 baud • Originate or Answer • No coils, only low cost components • TTL input and output-serial • Connect 8 Ω speaker and crystal mic. directly to board • Uses XR FSK demodulator • Requires +5 volts • Board only $7.60 Part No. 109, with parts $29.95 Part No. 109A

DISKETTES

Box of 10, 5" $29.95, 8" $39.95.
Plastic box, holds 10 diskettes, 5" - $4.50, 8" - $6.50.

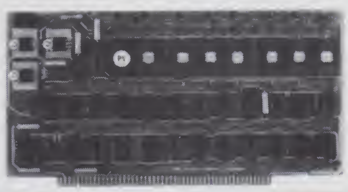
APPLE II SERIAL I/O INTERFACE



Baud rate is continuously adjustable from 0 to 30,000 • Plugs into any peripheral connector • Low current drain. RS-232 input and output • On board switch selectable 5 to 8 data bits, 1 or 2 stop bits, and parity or no parity either odd or even • Jumper selectable address • SOFTWARE • Input and Output routine from monitor or BASIC to teletype or other serial printer • Program for using an Apple II for a video or an intelligent terminal. Also can output in correspondence code to interface with some selectrics. • Also watches DTR • Board only $15.00 Part No. 2, with parts $42.00 Part No. 2A, assembled $62.00 Part No. 2C

8K EPROM PIICEON

Saves programs on PROM permanently (until erased via UV light) up to 8K bytes. Programs may be directly run from the program saver such as fixed routines or assemblers. • S-100 bus compatible • Room for 8K bytes of EPROM non-volatile memory (2708's). • Onboard PROM programming • Address relocation of each 4K of memory to any 4K boundary within 64K • Power on jump and reset jump option for "turnkey" systems and computers without a front panel • Program saver software available • Solder mask both sides • Full silkscreen for easy assembly. Program saver software in 1 2708 EPROM $25. Bare board $35 including custom coil, board with parts but no EPROMS $139, with 4 EPROMS $179, with 8 EPROMS $219.



T.V. TYPEWRITER

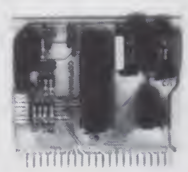
• Stand alone TVT • 32 char/line, 16 lines, modifications for 64 char/line included • Parallel ASCII (TTL) input • Video output • 1K on board memory • Output for computer controlled curser • Auto scroll • Non-destructive curser • Curser inputs: up, down, left, right, home, EOL, EOS • Scroll up, down • Requires +5 volts at 1.5 amps, and -12 volts at 30 mA • All 7400, TTL chips • Char. gen. 2513 • Upper case only • Board only $39.00 Part No. 106, with parts $145.00 Part No. 106A

TAPE INTERFACE

• Play and record Kansas City Standard tapes • Converts a low cost tape recorder to a digital recorder • Works up to 1200 baud • Digital in and out are TTL-serial • Output of board connects to mic. in of recorder • Earphone of recorder connects to input on board • No coils • Requires +5 volts, low power drain • Board only $7.60 Part No. 111, with parts $29.95 Part No. 111A

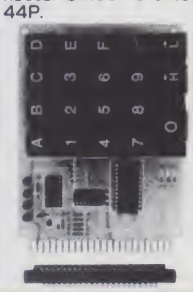
UART & BAUD RATE GENERATOR

• Converts serial to parallel and parallel to serial • Low cost on board baud rate generator • Baud rates: 110, 150, 300, 600, 1200, and 2400 • Low power drain +5 volts and -12 volts required • TTL compatible • All characters contain a start bit, 5 to 8 data bits, 1 or 2 stop bits, and either odd or even parity. • All connections go to a 44 pin gold plated edge connector • Board only $12.00 Part No. 101, with parts $35.00 Part No. 101A, 44 pin edge connector $4.00 Part No. 44P



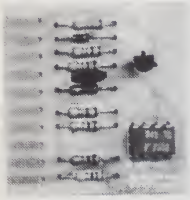
HEX ENCODED KEYBOARD E.S.

This HEX keyboard has 19 keys, 16 encoded with 3 user definable. The encoded TTL outputs, 8-4-2-1 and STROBE are debounced and available in true and complement form. Four onboard LEDs indicate the HEX code generated for each key depression. The board requires a single +5 volt supply. Board only $15.00 Part No. HEX-3, with parts $49.95 Part No. HEX-3A. 44 pin edge connector $4.00 Part No. 44P.



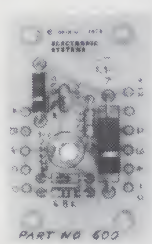
RS-232/ TTL INTERFACE

• Converts TTL to RS-232, and converts RS-232 to TTL • Two separate circuits • Requires -12 and +12 volts • All connections go to a 10 pin gold plated edge connector kit $ 9.95 Part No. 232A 10 Pin edge connector $3.00 Part No. 10P



RS-232/TTY INTERFACE

This board has two active circuits, one converts RS-232 to 20mA, and the other converts 20mA to RS-232. Requires +12 and -12 volts. $9.95 Part No. 600A Kit.



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FDC-1 FLOPPY CONTROLLER BOARD will drive shugart, pertek, remex 5" & 8" drives up to 8 drives, on board PROM with power boot up, will operate with CPM (not included). PCBD $42.95

FPB-1 Front Panel. (Finally) IMSAI size hex displays. Byte or instruction single step. PCBD $42.95

MEM-1A 8Kx8 fully buffered, S-100, uses 2102 type RAMS. PCBD .... $24.95, $168 Kit

QMB-12 MOTHER BOARD, 13 slot, terminated, S-100 board only .... $34.95 $89.95 Kit

CPU-1 8080A Processor board S-100 with 8 level vector interrupt PCBD .. $25.95 $89.95 Kit

RTC-1 Realtime clock board. Two independent interrupts. Software programmable. PCBD .... $25.95, $60.95 Kit

EPM-1 1702A 4K EPROM card PCBD .... $25.95 $49.95 with parts less EPROMS

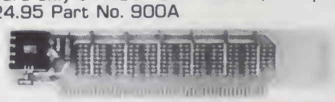
EPM-2 2708/2716 16K/32K EPROM card PCBD .... $24.95 $49.95 with parts less EPROMS

QMB-9 MOTHER BOARD. Short Version of QMB-12. 9 Slots PCBD .... $30.95 $67.95 Kit

MEM-2 16Kx8 Fully Buffered 2114 Board PCBD .... $25.95, $269.95 Kit

S-100 BUS ACTIVE TERMINATOR

Board only $14.95 Part No. 900, with parts $24.95 Part No. 900A



DC POWER SUPPLY

• Board supplies a regulated +5 volts at 3 amps., +12, -12, and -5 volts at 1 amp. • Power required is 8 volts AC at 3 amps., and 24 volts AC C.T. at 1.5 amps. • Board only $12.50 Part No. 6085, with parts excluding transformers $42.50 Part No. 6085A

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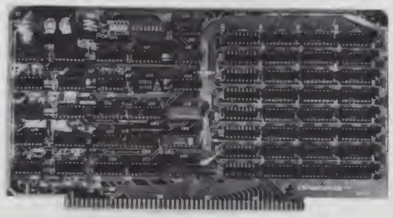
SD EXPANDORAM

The EXPANDORAM is available in versions from 16K up to 64K, so for a minimum investment you can have a memory system that will grow with your needs. This is a dynamic memory with the invisible on-board refresh, and IT WORKS!

- Bank Selectable
- Phantom
- Power 8VDC, +16VDC, 5 Watts
- Lowest Cost Per Bit
- Uses Major Brand 16K RAMS
- PC Board is doubled solder masked and has silk-screened parts layout
- Extensive documentation clearly written



- Complete kit includes all Sockets for 64K
- Memory access time: 375ns, Cycle time: 500ns.
- No wait states required
- 16K boundaries and Protection, via Dip Switches
- Designed to work with Z-80, 8080, 8085 CPU's

EXPANDORAM 64K Kit (16K Ram)

16K	$239.95
32K	309.95
48K	379.95
64K	449.95

SD'S PROM 100 PROM Programmer Board

The PROM-100 Programmer is a development tool for S-100 Bus computer systems. The Zero Insertion Force Programming Socket extends above the card cage height for easy access to PROM devices. Software verifies PROM erasure, verifies program loading and provides for reading of object file from Disk or PROM and programming into PROM/EPROM. Features include: On-board generated 25vdc Programming pulse, TTL compatible, maximum programming time for 16,389 bits is 100 seconds. Programs: 2708, Intel 2758, 2716, 2732 and TI 2516. DIP Selectable EPROM type.

PROM-100 Board Kit $149.95

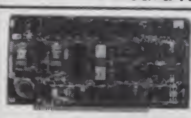
SD'S SBC-200 SINGLE BOARD COMPUTER — Kit $289.95

S-100 Bus compatible and based on the powerful Z80 microprocessor, the SBC-200 meets the needs of a Z-80 CPU board with many additional features. Ideal for Industrial and control applications. All of the same features that have made the SBC-100 famous, PLUS 4MHz OPERATION. • S-100 Bus Compatible • Z80 Central Processing Unit • 1024 Bytes of Random Access Memory • 8K Bytes of PROM using 2716 • Serial Input/Output Port (with Asynchronous and Synchronous Operation) • Parallel Input and Output Ports • Four Channel Counter/Timer (Z80-CTC) • Software Programmable Baud Rate Generator • No-Front Panel Required for Operation • 4 MHz Operation.

SD'S VERSAFLOPPY II

• IBM 3740 Compatible Soft Sectored Format for Single Density Drives • Operates with Single and Dual Sided Drives, Single or Double Density Drives and 5" & 8" Drives — in any combination of four simultaneously • Drive Select and Side Select Circuitry • S-100 Bus Compatible • Vectored Interrupt Operation Optional • Phase Locked Loop Data Recovery Circuit • Operates with Z80 CPU's • Uses FD1791-1 Controller Chip • Ther Versafloppy II incorporates all the possible features of a flexible disk drive controller into one board. Capable of handling four drives simultaneously, combinations of any variety are possible, such as 5" single sided, 8" dual density dual sided, 5" dual density single sided. Most popular drives are controlled directly with the Versafloppy II. The operating system for the Versafloppy II is the extremely powerful SDOS available for SD Systems. Diagnostic and control software available to complete your disk system.

KIT $335.95



SD'S VDB-8024 VIDEO DISPLAY BOARD

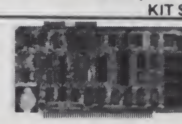
The VDB-8024 features its own on-board Z80 microprocessor. This gives the capability of using software (included in ROM) to control functions and enhancements without interference with the computer's CPU. Included in the special features: 80 characters by 24 lines display, keyboard power and interface, composite and separate video output, 2K on-board RAM, a total of 256 available characters, full cursor control, forward and reverse scrolling, underlining, field reverse, field protect enhancements, programmable characters.

KIT $329.95 A&T $389.95

SD'S "VERSAFLOPPY I" KIT

FEATURES: IBM 3740 soft sectored compatible, S-100 BNS Compatible for Z-80 or 8080. Controls up to 4 drives (single or double sided). Directly controls the following drives: Sugart SA400/450 Mini Floppy • Shugart SA800/850 Standard Floppy • PERSCI 70 and 277 • MFE 700/750 • CDC 9404/9406

$189.95



SD'S SBC-100 SINGLE BOARD COMPUTER

The SBC-100 provides a complete micro-computer on a single board! The Z80 microprocessor is used as the heart of the SBC-100. The SBC-100 meets all the requirements of a Z80 CPU board with the added features of I/O ports, counter/timer channels, on board RAM, provisions for PROM/ROM and a software programmable baud rate generator. S-100 Bus compatible, the SBC-100 features are: 8K bytes of available PROM, 1024 bytes on-board RAM, Serial I/O with both synchronous and asynchronous operation, Parallel I/O ports, Operational Vectored Interrupts, and Four Counter/Timer Channels. SD Monitor available for RS-232 and Video Terminals. Disk based system software also available.

SBC-100 KIT $249.95

TARBELL FLOPPY DISK INTERFACE

Compatible with Z80 & 8080. S-100 Bus. Uses CPM operating system. Plugs directly into your IMSAI or ALTAIR • Fastest transfer rate

KIT $190.00 Assembled & Tested $260.00

TARBELL CASSETTE INTERFACE

Plugs directly into your IMSAI or ALTAIR • Fastest transfer rate • Extremely reliable • Phase encoded • 4 extra status & control lines

KIT $99.95

SSM

CB2 Z-80 CPU Board Kit $186.00

Operates at 2 MHZ or 4 MHZ by DIP switch selection and includes two sockets for 2716 or 2732 EPROMs or TMS 4016 2K RAMs. Jumper options generate the new IEEE S-100 signals.

SSM

VB3 80 Character Video Board Kit $299.95

• 80 char. per line, up to 51 lines • Graphics up to 160 × 204 matrix • Up to 256 user defined symbols (optional EPROM) • Composite video

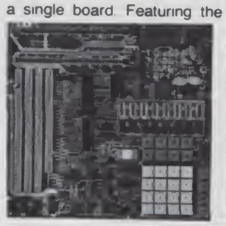
PB1 2708/2716 Programmer & 4K/8K EPROMBoard Kit SSM $124.00

• S-100 bus • 2 separate programming sockets for 2708 or 2716 (5V) EPROMs • Programming voltage generated on board — no need for an external power supply • Software control of 2708/2716 programming selection • LED indicator for programming mode and an on-off switch for programming voltage • 4 sockets for 4K of 2708 or 8K of 2716 EPROMs • Unused EPROM sockets do not enable data bus drive so the board is never committed to the full 4K or 8K of memory • Jumper selectable wait states (0-4) for fast or slow EPROMS

Z80 STARTER KIT

Kit: $279.95 Assembled & Tested $349.95

SD System's Z80 Starter Kit enables the novice to build a complete microcomputer on a single board. Featuring the powerful Z80 microprocessor, the Z80 Starter Kit features • Keyboard and Display • Audio Interface • PROM Programmer • Expansion and Wire Wrap Area • On Board RAM • 4 Channel Counter/Timer • Z-BUG Monitor in PROM • I/O Ports.



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- 65K Memory Expansion
- User EPROM 2716

IO4 2 Parallel/2 Serial I/O Board Kit $126.00

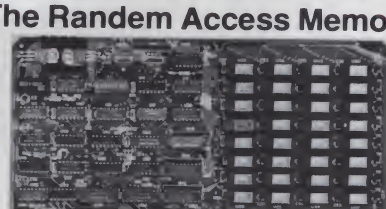
• S-100 bus • 2 serial I/O ports (2 in & 2 out) • Independent baud-rate selection from 55 to 9600 baud • Regulated +5V, +12V & −12V outputs provided on both serial headers • 2 latched parallel I/O ports (2 in & 2 out) • Independent DIP switches for setting address • Interrupt capability provided for on serial and parallel I/O ports • +8V @ 0.95A, +16V @ 0.6A, & −16V @ 80mA typical SSM

VB1B VIDEO BOARD KIT $124.00

• S-100 bus • 64 or 32 characters per line (DIP switch selectable), 16 lines • Graphics 128 × 48 matrix • Upper case, lower case, Greek characters, symbols and numbers • 7 × 9 dot character matrix • Black-on-white or white-on-black • Timing 60Hz vertical rate, 16.2KHz horizontal rate, Crystal 12.44MHz • Parallel and composite video output (US TV signals), separate video, horizontal and vertical sync SSM

SD'S EXPANDORAM II
The Randem Access Memory

- S-100 Bus Compatible
- Up to 4Mhz Operation
- Expandable Memory from 16K to 256K
- DIP Switch Selectable Boundaries
- Uses 16K (4116) or 64K (4164) Memory Devices
- Page Mode Operation Allows up to 8 Memory Boards on Bus
- Operates with Z80 CPU's
- Phantom Output Disable
- Invisible Refresh (Synchronized with Wait States)



SD Systems' ExpandoRAM II is a dynamic RAM board with capacities from 16K bytes (4116) to 256K bytes (4164). It operates on the industry S-100 Bus. The design allows 8 boards to operate from the same S-100 Bus. The ExpandoRAM II is compatible with most S-100 CPU's based on the Z80 microprocessor.

EXPANDORAM II KIT

16K	$295.95
32K	369.95
48K	444.95
64K	519.95

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Berkshire	NewBear Computing Store
GUAM	Marianas Electronics
PANAMA	
Panama City	Sonitel, S.A.
Panama City	Tropelco, S.A.
SINGAPORE	Applied Digital System
SINGAPORE	Inter-Trade (PTE.) Ltd.
SINGAPORE	Sys-Tech
SWEDEN	
Stockholm	LSI Electronics HB
Umea	Interkomponent
WEST INDIES	
Port of Spain, Trinidad	The Hobby Centre

For Distributor Information, write or phone JIM-PAK® 1355 Shoreway Road, Belmont, CA 94002 (415) 592-8097

Jim-pak® electronic components

Quality Kits

Function Generator Kit

Provides three basic waveforms: sine, triangle and square wave. Frequency range from 1 Hz to 100K Hz. Output amplitude from 0 volts to over 6 volts (peak to peak). Uses a 12V supply or a ±6V split supply. Includes chip, P.C. Board, components & instructions.

JE2206B $19.95

Digital Thermometer Kit

Dual sensors — switching control for indoor/outdoor or dual monitoring. Continuous LED .8" ht. display. Range: -40°F to 199°F / -40°C to 100°C. Accuracy ±1° nominal. Set for Fahrenheit or Celsius. Simulated walnut case. AC wall adapter included.
Size: 3¼"h x 6-5/8"w x 1-3/8"d.

JE300 .... $39.95

Digital Stopwatch Kit

Use Intersil 7205 Chip. Plated thru double-sided P.C. Board. Red LED display. Times to 59 minutes, 59.59 seconds with auto reset. Quartz crystal controlled. Three stopwatches in one: single event, split (cummulative) and taylor (sequential timing). Uses 3 penlite batteries.

Size: 4.5" x 2.15" x .90"

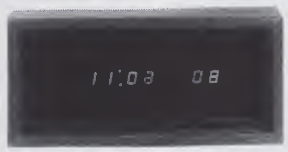
JE900 .... $39.95

4-Digit Clock Kit

Bright .357" ht. red display. Sequential flashing colon. 12 or 24 hour operation. Black extruded aluminum case. Pressure switches for hours, minutes and hold functions. Includes all components, case and wall transformer. Size: 3¼" x 1¾" x 1¼"

JE730 .... $14.95

6-Digit Clock Kit



Bright .300 ht. common cathode display. Uses MM-5314 clock chip. Switches for hours, minutes and hold functions. Hours easily viewable to 20 ft. Simulated walnut case. 115VAC operation. 12 or 24 hour operation. Includes all components, case and wall transformer. Size: 6¾" x 3-1/8" x 1¾"

JE701 .... $19.95

Jumbo 6-Digit Clock Kit

Four .630" ht. and two .300" ht. comm. anode displays. Uses MM5314 clock chip. Switches for hrs., mins., and hold functions. Hours viewable to 30 ft. Sim. walnut case. 115VAC operation. 12 or 24 hour operation. Incl. all components, case and wall transformer. Size: 6¾" x 3-1/8" x 1¾"

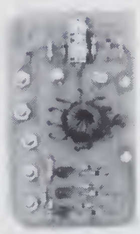
JE747 .... $29.95

Regulated Power Supply Kit

Uses LM309K. Heat sink provided. PC board construction. Provides solid 1 amp @ 5 volts. Includes components, hardware & instructions. Size: 3½" x 5" x 2"h

JE200 .... $14.95

Multi-Voltage Board Kit

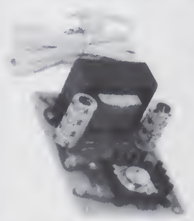


**ADAPTS TO JE200
SUPPLIES ±5V, ±9V and ±12V**

Independent load rating at single terminal. ±12V:160mA, ±9V:200 mA, –5V:250mA. DC/DC converter with +5V input. Toriodal hi-speed switching XMFR. Short circuit protection. PC board construction. Piggy-back to JE200 board. Size: 3½" x 2" x 9/16"h

JE205 .... $12.95

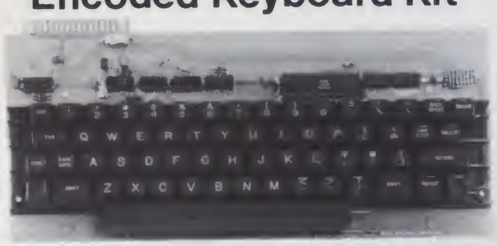
Variable Power Supply Kit



Full 1.5 amp @ 5-10V output. Up to .5 amp @ 15V output. Heavy duty transformer. Three-terminal I.C. voltage regulator. Heat sink provided for cooling efficiency. PC board construction. 120VAC input.
Size: 3½" x 5" x 2"h

JE210 .... $19.95

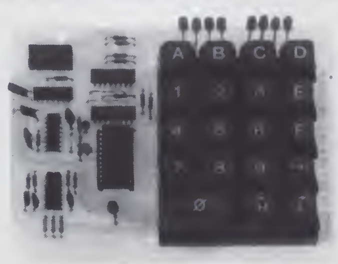
62-Key ASCII Encoded Keyboard Kit



The **JE610 ASCII KEYBOARD KIT** can be interfaced into most any computer system. The JE610 kit comes complete with an industrial grade keyboard switch assembly (62-keys), IC's, sockets, connector, electronic components and a double-sided printed wiring board. The keyboard assembly requires +5V @ 150mA and –12V @ 10mA for operation. Features: 60 keys generate the full 128 characters, upper and lower case ASCII set. Fully buffered. Two user-define keys provided for custom applications. Caps lock for upper case-only alpha characters. Utilizes a 2376 (40-pin) encoder read-only memory chip. Outputs directly compatible with TTL/DTL or MOS logic arrays. Easy interfacing with a 16-pin dip or 18-pin edge connector.

JE610 .... $79.95

Hexadecimal Encoder Kit



FULL 8-BIT LATCHED OUTPUT — 19-KEY KEYBOARD

The **JE600 ENCODER KEYBOARD** provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8-bit microprocessor or 8-bit memory circuits. Three (3) additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with 9 LED readouts. Also included is a key entry strobe. Features: Full 8-bit latched output for microprocessor use. Three user-define keys with one being bistable operation. Debounce circuit provided for all 19 keys. 9 LED readouts to verify entries. Easy interfacing with standard 16-pin IC connector. Only +5VDC required for operation.

JE600 .... $59.95

(Prices Subject To Change)

Reader Service—see page 227

7400 TTL

SN7400N	.16	SN7470N	.29	SN74160N	.89
SN7401N	.18	SN7472N	.29	SN74161N	.89
SN7402N	.18	SN7473N	.35	SN74162N	1.95
SN7403N	.18	SN7474N	.35	SN74163N	.89
SN7404N	.18	SN7475N	.49	SN74164N	.89
SN7405N	.20	SN7476N	.35	SN74165N	.89
SN7406N	.29	SN7479N	5.00	SN74166N	1.25
SN7407N	.29	SN7480N	.50	SN74167N	1.95
SN7408N	.20	SN7482N	.99	SN74170N	1.59
SN7409N	.20	SN7483N	.59	SN74172N	6.00
SN7410N	.18	SN7485N	.79	SN74173N	1.25
SN7411N	.25	SN7486N	.35	SN74174N	.89
SN7412N	.25	SN7489N	1.75	SN74175N	.79
SN7413N	.40	SN7490N	.45	SN74176N	.79
SN7414N	.70	SN7491N	.59	SN74177N	.79
SN7416N	.25	SN7492N	.43	SN74179N	1.95
SN7417N	.25	SN7493N	.43	SN74180N	.79
SN7420N	.20	SN7494N	.65	SN74181N	1.95
SN7421N	.29	SN7495N	.65	SN74182N	.79
SN7422N	.39	SN7496N	.65	SN74184N	1.95
SN7423N	.25	SN7497N	3.00	SN74185N	1.95
SN7425N	.29	SN74100N	.89	SN74186N	9.95
SN7426N	.29	SN74107N	.35	SN74188N	3.95
SN7427N	.25	SN74109N	.59	SN74190N	1.25
SN7429N	.39	SN74116N	1.95	SN74191N	1.25
SN7430N	.20	SN74121N	.35	SN74192N	.79
SN7432N	.25	SN74122N	.39	SN74193N	.79
SN7437N	.25	SN74123N	.49	SN74194N	.89
SN7438N	.25	SN74125N	.49	SN74195N	.69
SN7439N	.25	SN74126N	.49	SN74196N	.89
SN7440N	.20	SN74132N	.75	SN74197N	.89
SN7441N	.89	SN74136N	.75	SN74198N	1.49
SN7442N	.49	SN74141N	.79	SN74199N	1.49
SN7443N	.75	SN74142N	2.95	SN74S200	4.95
SN7444N	.75	SN74143N	2.95	SN74251N	.99
SN7445N	.75	SN74144N	2.95	SN74279N	.79
SN7446N	.69	SN74145N	.79	SN74283N	2.25
SN7447N	.59	SN74147N	1.95	SN74284N	3.95
SN7448N	.79	SN74148N	1.29	SN74285N	3.95
SN7450N	.20	SN74150N	.89	SN74365N	.69
SN7451N	.20	SN74151N	.59	SN74366N	.69
SN7453N	.20	SN74152N	.59	SN74367N	.69
SN7454N	.20	SN74153N	.59	SN74368N	.69
SN7459A	.25	SN74154N	.99	SN74390N	1.95
SN7460N	.20	SN74155N	.79	SN74393N	1.95
		SN74156N	.79		
		SN74157N	.65		

C/MOS

CD4000	.23	CD4028	.89	CD4070	.55
CD4001	.23	CD4029	1.19	CD4071	.23
CD4002	.23	CD4030	.49	CD4072	.49
CD4006	1.19	CD4035	.99	CD4078	1.39
CD4007	.25	CD4040	1.19	CD4081	.23
CD4009	.49	CD4041	1.25	CD4082	.23
CD4010	.49	CD4042	.99	CD4093	.99
CD4011	.23	CD4043	.89	CD4098	2.49
CD4012	.25	CD4044	.89	MC14409	14.95
CD4013	.39	CD4046	1.79	MC14410	14.95
CD4014	1.39	CD4047	2.50	MC14411	14.95
CD4015	1.19	CD4048	1.35	MC14419	4.95
CD4016	.49	CD4049	.49	MC14433	19.95
CD4017	1.19	CD4050	.49	MC14506	.75
CD4018	.99	CD4051	1.19	MC14507	.99
CD4019	.49	CD4053	1.19	MC14562	14.50
CD4020	1.19	CD4056	2.95	MC14583	3.50
CD4021	1.39	CD4059	9.95	CD4508	3.95
CD4022	1.19	CD4060	1.49	CD4510	1.39
CD4023	.23	CD4066	.79	CD4511	1.29
CD4024	.79	CD4068	.39	CD4515	2.95
CD4025	.23	CD4069	.45	CD4518	1.29
CD4026	2.25			CD4520	1.29
CD4027	.69			CD4566	2.25

74C00

74C00	.39	74C85	2.49	74C163	2.49
74C02	.39	74C90	1.95	74C164	2.49
74C04	.39	74C93	1.95	74C173	2.60
74C08	.49	74C95	1.95	74C192	2.49
74C10	.39	74C107	1.25	74C193	2.49
74C14	1.95	74C151	2.90	74C195	2.49
74C20	.39	74C154	3.00	74C922	7.95
74C30	.39	74C157	2.15	74C923	6.25
74C42	1.95	74C160	2.49	74C925	8.95
74C48	2.49	74C161	2.49	74C926	8.95
74C73	.89			80C95	1.50
74C74	.89			80C97	1.50

LINEAR

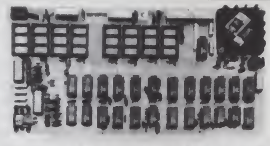
78MG	1.75	LM340K-18	1.35	LM710N	.79
LM106H	.99	LM340K-24	1.35	LM711N	.39
LM300H	.80	LM340T-5	1.25	LM723N/H	.55
LM301CN/H	.35	LM340T-6	1.25	LM733N	1.00
LM302H	.75	LM340T-8	1.25	LM739N	1.19
LM304H	1.00	LM340T-12	1.25	LM741CN/H	.35
LM305H	.60	LM340T-15	1.25	LM741-14N	.39
LM307CN/H	.35	LM340T-18	1.25	LM747N/H	.79
LM308CN/H	1.00	LM340T-24	1.25	LM748N/H	.39
LM309H	1.10	LM358N	1.00	LM1310N	1.95
LM309K	1.25	LM370N	1.95	LM1458CN/H	.59
LM310CN	1.15	LM373N	3.25	MC1488N	1.95
LM311N/H	.90	LM377N	4.00	MC1489N	1.95
LM312H	1.95	LM380N	1.25	LM1496N	.95
LM317K	6.50	LM380CN	.99	LM1556V	1.75
LM318CN/H	1.50	LM381N	1.79	MC1741SCP	3.00
LM319N	1.30	LM382N	1.79	LM2111N	1.95
LM320K-5	1.35	NE501N	8.00	LM2901N	2.95
LM320K-5.2	1.35	NE510A	6.00	LM3053N	1.50
LM320K-12	1.35	NE529A	4.95	LM3065N	1.49
LM320K-15	1.35	NE531H/V	3.95	LM3900N(3401)	.59
LM320K-18	1.35	NE536T	6.00	LM3905N	1.49
LM320K-24	1.35	NE540L	6.00	LM3909N	1.25
LM320T-5	1.25	NE544N	4.95	MC5558V	.59
LM320T-5.2	1.25	NE550N	1.30	8038B	4.95
LM320T-8	1.25	NE555V	.39	LM75450N	.49
LM320T-12	1.25	NE556N	.99	75451CN	.39
LM320T-15	1.25	NE560B	5.00	75452CN	.39
LM320T-18	1.25	NE562B	5.00	75453CN	.39
LM320T-24	1.25	NE565N/H	.99	75454CN	.39
LM323K-5	5.95	NE566CN	1.75	75491CN	.79
LM324N	1.49	NE567V/H	.99	75492CN	.89
LM339N	.99	NE570N	4.95	75493N	.89
LM340K-5	1.35	LM703CN/H	.69	75494CN	.89
LM340K-6	1.35	LM709N/H	.29	RC4136	1.25
LM340K-8	1.35			RC4151	3.95
LM340K-12	1.35			RC4194	4.95
LM340K-15	1.35			RC4195	4.49

74LS00TTL

74LS00	.29	74LS47	.89	74LS138	.89
74LS01	.29	74LS51	.29	74LS139	.89
74LS02	.29	74LS54	.29	74LS151	.89
74LS03	.29	74LS55	.29	74LS155	.89
74LS04	.35	74LS73	.45	74LS157	.89
74LS05	.35	74LS74	.45	74LS160	1.15
74LS08	.29	74LS75	.59	74LS161	1.15
74LS09	.35	74LS76	.45	74LS162	1.25
74LS10	.29	74LS78	.49	74LS163	1.15
74LS11	.75	74LS83	.89	74LS164	1.25
74LS13	.59	74LS85	1.25	74LS175	.99
74LS14	1.25	74LS86	.45	74LS181	2.49
74LS15	.35	74LS90	.59	74LS190	1.15
74LS20	.29	74LS92	.75	74LS191	1.15
74LS21	.35	74LS93	.75	74LS192	1.15
74LS22	.35	74LS95	.99	74LS193	1.15
74LS26	.35	74LS96	1.15	74LS194	1.15
74LS27	.35	74LS107	.45	74LS195	1.15
74LS28	.35	74LS109	.45	74LS253	.99
74LS30	.29	74LS112	.45	74LS257	.89
74LS32	.35	74LS123	1.25	74LS258	1.75
74LS37	.45	74LS125	.89	74LS260	.69
74LS40	.35	74LS132	.99	74LS279	.75
74LS42	.89	74LS136	.49	74LS367	.75
				74LS368	.75
				74LS670	2.49

Cromemco

Incorporated



8K Bytesaver II

Cromemco's 8K BYTESAVER® card provides a built-in programmer for the popular 2708 PROM and has the capacity for a full 8K bytes of PROM memory storage. The BYTESAVER® II also offers a number of new features including convenient switch selection of board address and Cromemco's powerful memory bank selection. The BYTESAVER® II is assembled and tested (Model 8KBS-W) for $245.

Memory Capacity: 8K bytes
Memory Type: 2708 PROM or equivalent
Memory Access Time: 450 nanoseconds
Wait States at 2MHz: none required
Wait States at 4MHz: one per machine cycle
Bus: S-100
Power Requirements: +8V @ 0.8A, +18V @ 0.4A, −18V @ 0.2A
Operating Environment: 0-55°C.

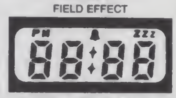
Assembled
8KBS-W $245.00

DISCRETE LEDS

.200" dia.			.125" dia.		
XC556R red	5/$1		XC209R red	5/$1	
XC556G green	4/$1		XC209G green	4/$1	
XC556Y yellow	4/$1		XC209Y yellow	4/$1	
XC556C clear	4/$1				
.200" dia.			.185" dia.		
XC22R red	5/$1		XC526R red	5/$1	
XC22G green	4/$1		XC526G green	4/$1	
XC22Y yellow	4/$1		XC526Y yellow	4/$1	
.170" dia.			XC526C clear	4/$1	
MV10B red	4/$1		.190" dia.		
.085" dia.			XC111R red	5/$1	
MV50 red	6/$1		XC111G green	4/$1	
			XC111Y yellow	4/$1	
			XC111C clear	4/$1	

INFRA-RED LED
1/4"x1/4"x1/16" flat
5/$1

TIMEX T1001
LIQUID CRYSTAL DISPLAY CLASS II
FIELD EFFECT



4 DIGIT - .5" CHARACTERS
THREE ENUNCIATORS
2.00" X 1.20" PACKAGE
INCLUDES CONNECTOR

T1001-Transmissive $7.95
T1001A-Reflective 8.25

DISPLAY LEDS

TYPE	POLARITY	HT	PRICE	TYPE	POLARITY	HT	PRICE
MAN 1	Common Anode-red	.270	2.95	MAN 6730	Common Anode-red ± 1	.560	.99
MAN 2	5 x 7 Dot Matrix-red	.300	4.95	MAN 6740	Common Cathode-red-D.D.	.560	.99
MAN 3	Common Cathode-red	.125	.25	MAN 6750	Common Cathode-red ± 1	.560	99
MAN 4	Common Cathode-red	.187	1.95	MAN 6760	Common Anode-red	.560	.99
MAN 7G	Common Anode-green	.300	1.25	MAN 6780	Common Cathode-red	.560	.99
MAN 7Y	Common Anode-yellow	.300	.99	DL701	Common Anode-red ± 1	.300	.99
MAN 72	Common Anode-red	.300	.75	DL704	Common Cathode-red	.300	99
MAN 74	Common Cathode-red	.300	1.25	DL707	Common Anode-red	.300	.99
MAN 82	Common Anode-yellow	.300	49	DL728	Common Cathode-red	.500	1.49
MAN 84	Common Cathode-yellow	.300	.99	DL741	Common Anode-red	.600	1.25
MAN 3620	Common Anode-orange	.300	.49	DL746	Common Anode-red ± 1	.630	1.49
MAN 3630	Common Anode-orange ± 1	.300	.99	DL747	Common Anode-red	.600	1.49
MAN 3640	Common Cathode-orange	.300	.99	DL749	Common Cathode-red ± 1	.630	1.49
MAN 4610	Common Anode-orange	.300	.99	DL750	Common Cathode-red	.600	1.49
MAN 4640	Common Cathode-orange	.400	.99	DL33B	Common Cathode-red	.110	.35
MAN 4710	Common Anode-red	.400	.99	FND70	Common Cathode	.250	.69
MAN 4730	Common Anode-red ± 1	.400	.99	FND358	Common Cathode ± 1	.357	.99
MAN 4740	Common Cathode-red	.400	.99	FND359	Common Cathode	.357	.75
MAN 4810	Common Anode-yellow	.400	.99	FND503	Common Cathode(FND500)	.500	.99
MAN 4840	Common Cathode-yellow	.400	.99	FND507	Common Anode (FND510)	.500	.99
MAN 6610	Common Anode-orange-D.D.	.560	.99	5082-7730	Common Anode-red	.300	99
MAN 6630	Common Anode-orange ± 1	.560	.99	HDSP-3400	Common Anode-red	.800	1 50
MAN 6640	Common Cathode-orange-D.D.	.560	.99	HDSP-3403	Common Cathode red	800	1.50
MAN 6650	Common Cathode-orange ± 1	.560	.99	5082-7300	4 x 7 sgl. Digit-RHDP	.600	19.95
MAN 6660	Common Anode-orange	.560	.99	5082-7302	4 x 7 Sgl. Digit-LHDP	.600	19.95
MAN 6680	Common Cathode-orange	.560	.99	5082-7304	Overrange character (±1)	.600	15.00
MAN 6710	Common Anode-red-D.D.	.560	.99	5082-7340	4 x 7 Sgl. Digit-Hexadecimal	.600	22.50

RCA LINEAR

CA3013T	2.15	CA3082N	2.00
CA2023T	2.56	CA3083N	1.60
CA3035T	2.48	CA3086N	.85
CA3039T	1.35	CA3089N	3.75
CA3046N	1.30	CA3130T	1.39
CA3059N	3.25	CA3140T	1.25
CA3060N	3.25	CA3160T	1.25
CA3080T	.85	CA3401N	59
CA3081N	2.00	CA3600N	3.50

CALCULATOR CHIPS/DRIVERS

MM5725	$2.95
MM5738	2.95
DM8864	2.00
DM8865	1.00
DM8887	.75
DM8889	.75
9374 7 seg. C.A. LED driver	1 50

CLOCK CHIPS

MM5309	$4.95
MM5311	4.95
MM5312	4.95
MM5314	4.95
MM5316	6.95
MM5318	9.95
MM5369	2.95
MM5387/1998A	4.95
CT 7001	6.95

MOTOROLA

MC1408L7	$4.95
MC1408L8	5.75
MC1439L	2 95
MC3022P	2.95
MC3061P	3.50
MC4016(74416)	7.50
MC4024P	3.95
MC4040P	6.95
MC4044P	4.50

IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin LP	.$17	.16	.15	22 pin LP	$ .37	.36	.35
14 pin LP	.20	.19	.18	24 pin LP	.38	.37	.36
16 pin LP	.22	.21	.20	28 pin LP	.45	.44	.43
18 pin LP	.29	.28	.27	36 pin LP	.60	.59	.58
20 pin LP	.34	.32	.30	40 pin LP	.63	.62	.61

SOLDERTAIL STANDARD (TIN)

14 pin ST	$.27	.25	.24	28 pin ST	$ .99	.90	.81
16 pin ST	.30	.27	.25	38 pin ST	1.39	1.26	1.15
18 pin ST	.35	.32	.30	40 pin ST	1.59	1.45	1.30
24 pin ST	.49	45	.42				

SOLDERTAIL STANDARD (GOLD)

8 pin SG	$.30	.27	24	24 pin SG	$ .70	.63	.57
14 pin SG	.35	.32	29	28 pin SG	1.10	1.00	.90
16 pin SG	.38	.35	.32	36 pin SG	1.65	1.40	1.26
18 pin SG	52	.47	.43	40 pin SG	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

8 pin WW	$ 39	.38	31	22 pin WW	$ .95	.85	.75
10 pin WW	.45	.41	.37	24 pin WW	1.05	.95	.85
14 pin WW	.39	.38	.37	28 pin WW	1.40	1.25	1.10
16 pin WW	.43	.42	.41	36 pin WW	1.59	1.45	1.30
18 pin WW	.75	68	.62	40 pin WW	1.75	1.55	1.40
20 pin WW	.85	.79	.72				

1/4 WATT RESISTOR ASSORTMENTS – 5%

ASST. 1	5 ea	10 OHM / 27 OHM	12 OHM / 33 OHM	15 OHM / 39 OHM	18 OHM / 47 OHM	22 OHM / 56 OHM	50 PCS	$1.75
ASST. 2	5 ea	68 OHM / 180 OHM	82 OHM / 220 OHM	100 OHM / 270 OHM	120 OHM / 330 OHM	150 OHM / 390 OHM	50 PCS	1.75
ASST. 3	5 ea	470 OHM / 1.2K	560 OHM / 1.5K	680 OHM / 1.8K	820 OHM / 2.2K	1K / 2.7K	50 PCS	1.75
ASST. 4	5 ea	3.3K / 8.2K	3.9K / 10K	4.7K / 12K	5.6K / 15K	6.8K / 18K	50 PCS	1.75
ASST. 5	5 ea	22K / 56K	27K / 68K	33K / 82K	39K / 100K	47K / 120K	50 PCS	1.75
ASST. 6	5 ea	150K / 390K	180K / 470K	220K / 560K	270K / 680K	330K / 820K	50 PCS	1.75
ASST. 7	5 ea	1M / 2.7M	1.2M / 3.3M	1.5M / 3.9M	1.8M / 4.7M	2.2M / 5.6M	50 PCS	1.75

ASST. 8R Includes Resistor Assortments 1-7 (350 PCS.) **$9.95 ea.**

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AY-5-2376	Keyboard Encoder (88 keys)	14.95
HD0165	Keyboard Encoder (16 keys)	7.95
74C922	Keyboard Encoder (16 keys)	7.95
74C923	Keyboard Encoder (20 keys)	6.25

ICM CHIPS

ICM7045	CMOS Precision Timer	24.95
ICM7205	CMOS LED Stopwatch/Timer	19.95
ICM7207	Oscillator Controller	7.50
ICM7208	Seven Decade Counter	19.95
ICM7209	Clock Generator	6.95

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MCM6571	128 X 9 X 7 ASCII Shifted with Greek	13.50
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MCM6575	128 X 9 X 7 Alpha Control Char. Gen	13.50

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TL074CN	Quad Low Noise bi-fet Op Amp	2.49
TL494CN	Switching Regulator	4.49
TL496CP	Single Switching Regulator	1.75
11C90	Divide 10/11 Prescaler	19.95
95H90	Hi-Speed Divide 10/11 Prescaler	11.95
4N33	Photo-Darlington Opto-Isolator	3.95
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DS0026CH	5Mhz 2-phase MOS clock driver	3.75
TIL308	.27" red num. display w/integ. logic chip	10.95
MM5320	TV Camera Sync. Generator	14.95
MM5330	4½ Digit DPM Logic Block (Special)	3.95
LD110/111	3½ Digit A/D Converter Set	25.00/set
MC14433P	3½ Digit A/D Converter	13.95

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Photo Transistor Opto-Isolator
(Same as MCT 2 or 4N25)
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AY-3-8500-1 and 2.01 MHZ Crystal (Chip & Crystal)
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XR205	$8.40			XR2242CP	1.50
XR210	4.40			XR2264	4.25
XR215	4.40			XR2556	3.20
XR320	1.55			XR2567	2.99
XR-L555	1.50	JE2206KB	19.95	XR3403	1.25
XR555	.39	XR1800	3.20	XR4136	1.25
XR556	.99	XR2206	4.40	XR4151	3.95
XR567CP	.99	XR2207	3.85	XR4194	4.95
XR567CT	1.25	XR2208	5.20	XR4202	3.60
XR1310P	1.95	XR2209	1.75	XR4212	2.05
XR1468CN	3.85	XR2211	5.25	XR4558	.75
XR1488	1.95	XR2212	4.35	XR4739	1.15
XR1489	1.95	XR2240	3.45	XR4741	1.47

DIODES

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
				1N4002	100 PIV	1 AMP	12/1.00
				1N4003	200 PIV	1 AMP	12/1.00
1N746	3.3	400m	4/1.00	1N4004	400 PIV	1 AMP	12/1.00
1N751	5.1	400m	4/1.00	1N4005	600 PIV	1 AMP	10/1.00
1N752	5.6	400m	4/1.00	1N4006	800 PIV	1 AMP	10/1.00
1N753	8.2	400m	4/1.00	1N4007	1000 PIV	1 AMP	10/1.00
1N754	6.8	400m	4/1.00	1N3600	50	200m	6/1.00
1N757	9 0	400m	4/1.00	1N4148	75	10m	15/1.00
1N759	12.0	400m	4/1.00	1N4154	35	10m	12/1.00
1N959	8.2	400m	4/1.00	1N4733	5 1	1w	28
1N965	15	400m	4/1.00	1N4734	5.6	1w	28
1N5232	5.6	500m	28	1N4735	8.2	1w	28
1N5234	6.2	500m	28	1N4736	8.8	1w	28
1N5235	8.8	500m	28	1N4738	8.2	1w	28
1N5236	7.5	500m	28	1N4742	12	1w	28
1N5242	12	500m	28	1N4744	15	1w	28
1N5245	15	500m	28	1N1183	50 PIV	35 AMP	1.60
1N456	25	40m	8/1.00	1N1184	100 PIV	35 AMP	1.70
1N458	150	7m	6/1.00	1N1185	150 PIV	35 AMP	1.70
1N485A	180	10m	5/1.00	1N1186	200 PIV	35 AMP	1.80
1N4001	50 PIV	1 AMP	12/1.00	1N1188	400 PIV	35 AMP	3.00

SCR AND FW BRIDGE RECTIFIERS

C36D	15A @ 400V	SCR(2N1849)	$1.95
C36M	35A @ 600V	SCR	1.95
2N2328	1.6A @ 300V	SCR	.50
MDA 980-1	12A @ 50V	FW BRIDGE REC.	1.95
MDA 980-3	12A @ 200V	FW BRIDGE REC.	1.95

TRANSISTORS

C106B1	.50			2N3904	4/1.00
MPSA05	.30	2N3055	89	2N3905	4/1.00
MPSA06	5/1.00	MJE3055	1.00	2N3906	4/1.00
TIS97	6/1.00	2N3392	5/1.00	2N4013	3/1.00
TIS98	6/1.00	2N3398	5/1.00	2N4123	6/1.00
40409	1.75	PN3567	3/1.00	PN4249	4/1.00
40410	1.75	PN3568	4/1.00	PN4250	4/1.00
40673	1.75	PN3569	4/1.00	2N4400	4/1.00
2N918	4/1.00	MPS3638A	5/1.00	2N4401	4/1.00
2N2219A	2/1.00	MPS3702	5/1.00	2N4402	4/1.00
2N2221A	4/1.00	2N3704	5/1.00	2N4403	4/1.00
2N2222A	5/1.00	MPS3704	5/1.00	2N4409	5/1.00
PN2222 Plastic	7/1.00	2N3705	5/1.00	2N5086	4/1.00
2N2369A	4/1.00	MPS3705	5/1.00	2N5087	4/1.00
MPS2369	5/1.00	2N3706	5/1.00	2N5088	4/1.00
2N2484	4/1.00	MPS3706	5/1.00	2N5089	4/1.00
2N2906	4/1.00	2N3707	5/1.00	2N5129	5/1.00
2N2907	5/1.00	2N3711	5/1.00	PN5134	5/1.00
PN2907 Plastic	7/1.00	2N3724A	.65	PN5138	5/1.00
2N2925	5/1.00	2N3725A	1.00	2N5139	5/1.00
MJE2955	1.25	2N3772	2.25	2N5210	5/1.00
2N3053	2/1.00	2N3823	1.00	2N5449	3/1.00
		2N3903	5/1 00	2N5951	3/1.00

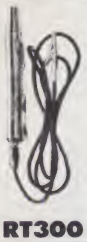
CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-99	100+		1-9	10-99	100+
10 pf	.05	.04	.03	.001µF	.05	.04	.035
22 pf	.05	.04	.03	.0047µF	.05	.04	.035
47 pf	.05	.04	.03	.01µF	.05	.04	.035
100 pf	.05	.04	.03	.022µF	.06	.05	.04
220 pf	.05	.04	.03	.047µF	.06	.05	.04
470 pf	.05	.04	035	1µF	.12	.09	.075
100 VOLT MYLAR FILM CAPACITORS							
001mf	12	.10	.07	022mf	.13	.11	.08
.0022	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	12	10	.07	.22mf	33	.27	.22
+20% DIPPED TANTALUMS (SOLID) CAPACITORS							
.1/35V	.28	.23	.17	1.5/35V	.30	.26	.21
.15/35V	.28	.23	.17	2.2/35V	.35	.31	.27
.22/35V	28	.23	.17	3.3/25V	.35	.31	.27
.33/35V	28	.23	17	4.7/25V	.33	.28	.23
.47/35V	.28	.23	.17	6.8/25V	.49	.45	.35
.68/35V	.28	.23	17	15/25V	.75	.68	.59
1.0/35V	.28	23	17	22/6V	.75	.60	.50
MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS							
Axial Lead				Radial Lead			
.47/50V	.15	13	.10	.47/25V	.15	.13	.10
1.0/50V	.16	.14	.11	.47/50V	.16	.14	.11
3.3/50V	.14	12	.09	1.0/16V	.15	.13	.10
4.7/25V	.15	13	.10	1.0/25V	.16	.14	.11
10/25V	.15	.13	.10	1.0/50V	.16	.14	.11
10/50V	.16	.14	.12	4.7/16V	.15	.13	.10
22/25V	.17	.15	.12	4.7/25V	.15	.13	.10
22/50V	.24	.20	.18	4.7/50V	.16	.14	.11
47/25V	.19	.17	.15	10/16V	.14	.12	.09
47/50V	.25	.21	.19	10/25V	.15	.13	.10
100/25V	.24	.20	.18	10/50V	.16	.14	.12
100/50V	.35	.30	.28	47/50V	.24	.21	.19
220/25V	.32	.28	.25	100/16V	.19	.15	.14
220/50V	.45	.41	.38	100/25V	.24	.20	.18
470/25V	.33	29	.27	100/50V	.35	.30	.28
1000/16V	.55	50	.45	220/16V	.23	.17	.16
2200/16V	.70	.62	.55	470/25V	.31	.28	26

Continuity Tester and Flashlight

ETCON



Convenient versatile tool for quickly checking continuity of dead circuits, switches, appliances, cords, fuses, motors, control equipment, coils and panel boards. Also tests circuits for low-resistance shorts and helps identify wires in multi-wire cables. Dozens of other uses. Plus the added convenience of a handy, durable flashlight. Uses two AA size penlight batteries (not furnished). Insulated clip prevents accidental shorting to case. Alligator clip has 48" lead with plug.

RT300 .... **$7.95**

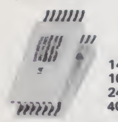
CSC CONTINENTAL SPECIALTIES

Logic Monitor

The Logic Monitor allows you to check logic levels on all 16 pins of any DTL, HTL, TTL, or CMOS device. It has a typical input impedance of 100K ohms and weighs a mere 3 oz. (85 grams). It has an input volt. range of 4V to 15V and draws a max. of 100mA@10V

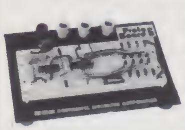
LM-1............ **$70.00**

Proto Clips



14-PIN CLIP	PC-14	$ 4.50
16-PIN CLIP	PC-16	$ 4.75
24-PIN CLIP	PC-24	$10.00
40-PIN CLIP	PC-40	$16.00

Proto Boards

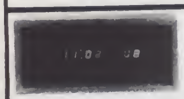


PB-6	$17.95
PB-100	19.95
PB-101	22.95
PB-102	26.95
PB-103	44.95
PB-104	55.95
PB-203	99.95
PB-203A	155.00
PB-203A-Kit	131.00

Jumbo 6-Digit Clock Kit

- Four .630"ht. and two .300"ht. common anode displays
- Uses MM5314 clock chip
- Switches for hours, minutes and hold functions
- Hours easily viewable to 30 feet
- Simulated walnut case
- 115 VAC operation
- 12 or 24 hour operation
- Includes all components, case and wall transformer
- Size: 6¾ x 3⅛ x 1¾

JE747............. **$29.95**



- Bright .300 ht. comm. cathode display
- Uses MM5314 clock chip
- Switches for hours, minutes and hold modes
- Hrs. easily viewable to 20 ft.
- Simulated walnut case
- 115 VAC operation
- 12 or 24 hr. operation
- Incl. all components, case & wall transformer
- Size: 6¾" x 3-1/8" x 1¾"

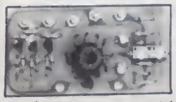
JE701

6-Digit Clock Kit $19.95

Regulated Power Supply

Uses LM309K. Heat sink provided. PC board construction. Provides a solid 1 amp @ 5 volts. Can supply up to ±5V, ±9V and ±12V with JE205 Adapter. Includes components, hardware and instructions. Size: 3½" x 5" x 2"H

JE200....... **$14.95**



ADAPTER BOARD —Adapts to JE200— ±5V, ±9V and ±12V

DC/DC converter with +5V input. Toriodal hi-speed switching XMFR. Short circuit protection. PC board construction. Piggy-back to JE 200 board. Size: 3½" x 2" x 9/16"H

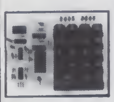
JE205 .... **$12.95**

MICROPROCESSOR COMPONENTS

8080A/8080A SUPPORT DEVICES		
8080A	CPU	$ 7.95
8212	8-Bit Input/Output	3.25
8214	Priority Interrupt Control	5.95
8216	Bi-Directional Bus Driver	3.49
8224	Clock Generator/Driver	3.95
8226	Bus Driver	3.49
8228	System Controller/Bus Driver	4.95
8238	System Controller	5.95
8251	Prog. Comm. 1/0 (USART)	7.95
8253	Prog. Interval Timer	14.95
8255	Prog. Periph. 1/0 (PPI)	9.95
8257	Prog. DMA Control	19.95
8259	Prog. Interrupt Control	19.95
6800/6800 SUPPORT DEVICES		
MC6800	MPU	$14.95
MC6802CP	MPU with Clock and Ram	24.95
MC6810API	128X8 Static Ram	5.95
MC6821	Periph. Inter. Adapt (MC6820)	7.49
MC6828	Priority Interrupt Controller	12.95
MC6830L8	1024X8 Bit ROM (MC68A30-8)	14.95
MC6850	Asynchronous Comm. Adapter	7.95
MC6852	Synchronous Serial Data Adapt.	9.95
MC6860	0-600 bps Digital MDDEM	12.95
MC6862	2400 bps Modulator	14.95
MC6880A	Quad 3-State Bus. Trans. (MC8T26)	2.25
MICROPROCESSOR CHIPS—MISCELLANEOUS		
Z80(780C)	CPU	$14 95
Z80A(780-1)	CPU	16.95
CDP1802	CPU	19.95
2650	MPU	19.95
6502	CPU	11 95
8035	8-Bit MPU w/clock, RAM, 1/0 lines	19.95
P8085	CPU	19.95
TMS9900JL	16-Bit MPU w/hardware, multiply & divide	49.95
SHIFT REGISTERS		
MM500H	Dual 25 Bit Dynamic	$.50
MM503H	Dual 50 Bit Dynamic	.50
MM504H	Dual 16 Bit Static	.50
MM506H	Dual 100 Bit Static	.50
MM510H	Dual 64 Bit Accumulator	.50
MM5016H	500/512 Bit Dynamic	.89
2504T	1024 Dynamic	3.95
2518	Hex 32 Bit Static	4.95
2522	Dual 132 Bit Static	2.95
2524	512 Static	.99
2525	1024 Dynamic	2.95
2527	Dual 256 Bit Static	2.95
2528	Dual 250 Static	4.00
2529	Dual 240 Bit Static	4.00
2532	Quad 80 Bit Static	2.95
3341	Fifo	6.95
74LS670	4X4 Register File (TriState)	2.49
UART'S		
A-Y-5-1013	30K BAUD	5 95

MICROPROCESSOR MANUALS			
M-Z80	User Manual		$7.50
M-CDP1802	User Manual		7.50
M-2650	User Manual		5.00
ROM'S			
2513(2140)	Character Generator(upper case)		$9 95
2513(3021)	Character Generator(lower case)		9.95
2516	Character Generator		10.95
MM5230N	2048-Bit Read Only Memory		1.95
RAM'S			
1101	256X1	Static	$1.49
1103	1024X1	Dynamic	.99
2101(8101)	256X4	Static	3.95
2102	1024X1	Static	1.75
21L02	1024X1	Static	1.95
2111(8111)	256X4	Static	3.95
2112	256X4	Static MOS	4.95
2114	1024X4	Static 450ns	7.95
2114L	1024X4	Static 450ns low power	10.95
2114-3	1024X4	Static 300ns	10.95
2114L-3	1024X4	Static 300ns low power	11.95
5101	256X4	Static	7.95
5280/2107	4096X1	Dynamic	4.95
7489	16X4	Static	1.75
74S200	256X1	Static Tristate	4.95
93421	256X1	Static	2.95
UPD414 (MK4027)	4K	Dynamic 16 pin	4.95
UPD416 (MK4116)	16K	Dynamic 16 pin 250ns	9 95
TMS4044-45NL	4K	Static	14.95
TMS4045	1024X4	Static	14.95
2117	16,384X1	Dynamic 350ns (house marked)	9.95
MM5262	2KX1	Dynamic	4/1.00
PROM'S			
1702A	2048	FAMOS	$5.95
2716INTEL	16K*	EPROM	59 95
TMS2516	16K*	EPROM	49 95
(2716)	*Requires single +5V power supply		
TMS2532	4KX8	EPROM	89.95
2708	8K	EPROM	10.95
2716 T.I	16K**	EPROM	29.95
	**Requires 3 voltages, —5V, +5V, +12V		
5203	2048	FAMOS	14 95
6301-1(7611)	1024	Tristate Bipolar	3.49
6330-1(7602)	256	Dpen C Bipolar	2.95
82S23	32X8	Dpen Collector	3.95
82S115	4096	Bipolar	19.95
82S123	32X8	Tristate	3.95
74186	512	TTL Open Collector	9 95
74188	256	TTL Open Collector	3 95
74S287	1024	Static	2.95

JE600 HEXADECIMAL ENCODER KIT



FEATURES:
- Full 8 bit latched output for microprocessor use
- 3 User Define keys with one being bistable operation
- Debounce circuit provided for all 19 keys
- LED readout to verify entries
- Easy interfacing with standard 16 pin 1C connector
- Only +5VDC required for operations

FULL 8 BIT LATCHED OUTPUT—19 KEYBOARD

The JE600 Encoder Keyboard provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8 bit microprocessor or 8 bit memory circuits. Three (3) additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with LED readouts. Also included is a key entry strobe

JE600 .... **$59.95**

Hexadecimal Keypad only $14.95

DIGITAL THERMOMETER KIT

- Dual sensors—switching control for indoor/outdoor or dual monitoring
- Continuous LED .8" ht. display
- Range: -40°F to 199°F / -40°C to 100°C
- Accuracy: ±1° nominal
- Set for Fahrenheit or Celsius reading
- Sim. walnut case - AC wall adapter incl.
- Size: 3-1/4"H x 6-5/8"W x 1-3/8"D

JE300 .... **$39.95**

62-Key ASCII Encoded Keyboard Kit

The JE610 62-Key ASCII Encoded Keyboard Kit can be interfaced into most any computer system. The JE610 Kit comes complete with an industrial grade keyboard switch assembly (62 keys), IC's, sockets, connector, electronic components and a double-sided printed wiring board. The keyboard assembly requires +5V @ 150mA and −12V @ 10mA for operation.

FEATURES:
- 60 Keys generate the full 128 characters, upper and lower case ASCII set
- Fully buffered
- 2 user-define keys provided for custom applications
- Caps lock for upper case only alpha characters
- Utilizes a 2376 (40 pin) encoder read only memory chip
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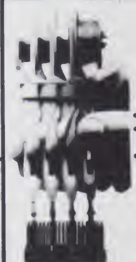

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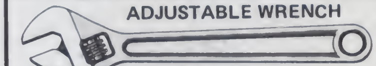

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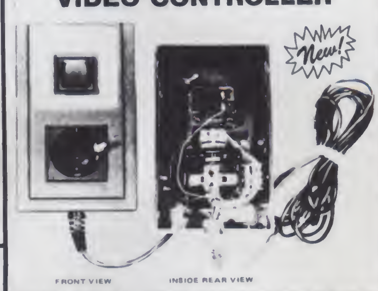

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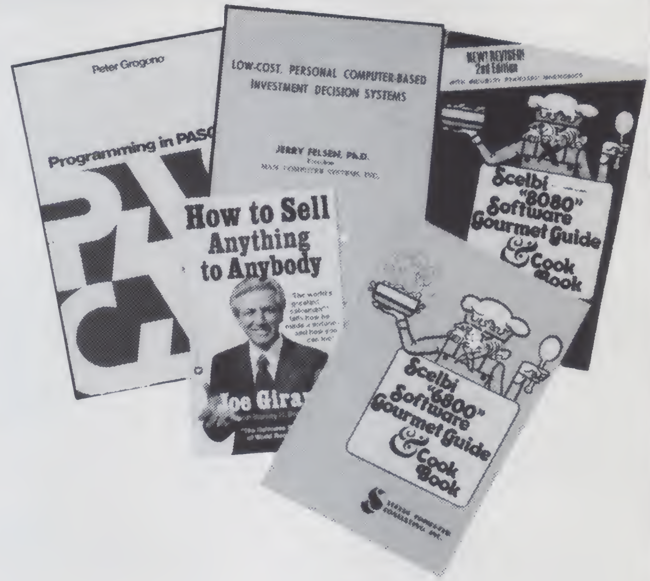

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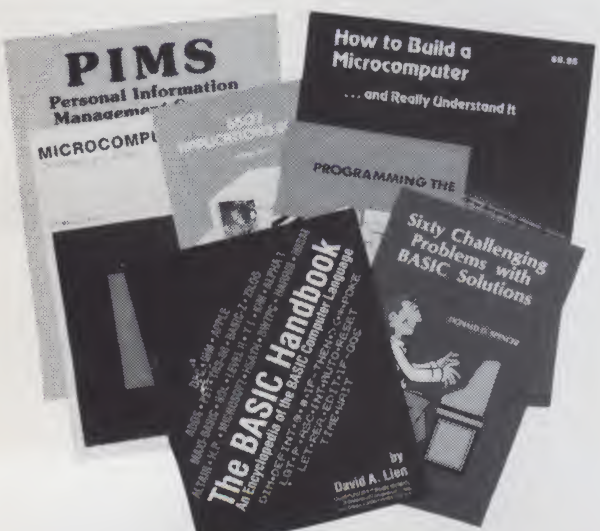

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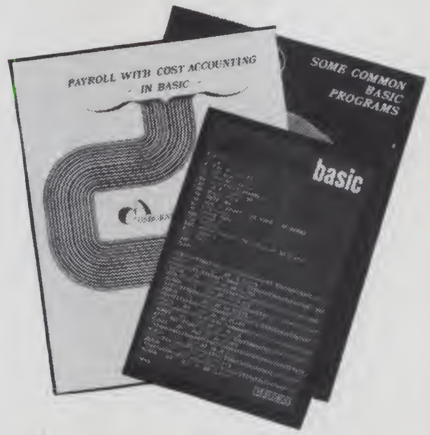

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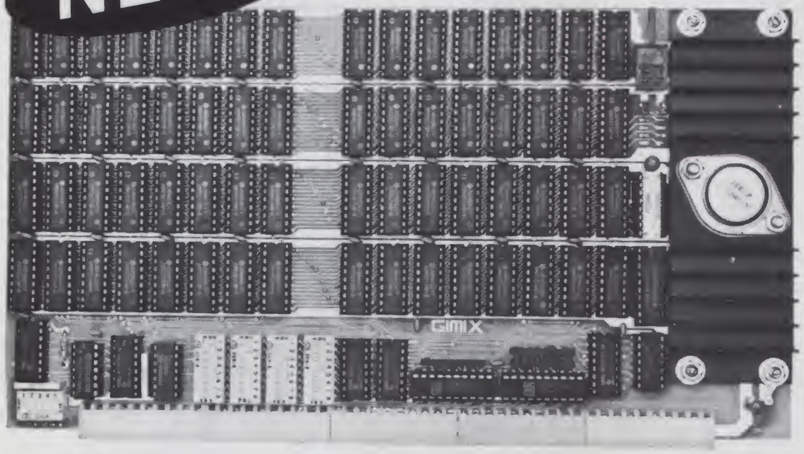

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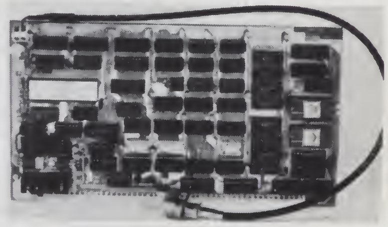

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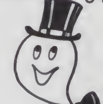

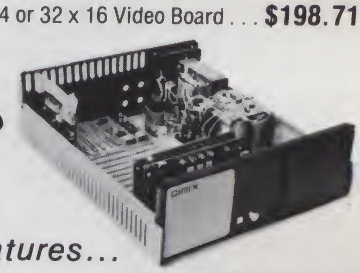

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